Institution: University of Cambridge

Unit of Assessment: 4

a. Context

Our peer-reviewed research in psychology, psychiatry and clinical neuroscience impacts on a wide range of stakeholders beyond academia: people using the NHS, industry, the voluntary sector, local and national government, and healthy members of the public. Using a variety of outlets, we aim to make an impact on society with national and international reach in terms of education; policy development; law; technology transfer and commercial enterprise; improvements in health-care; and contributions to cultural activities and the public understanding of science. The traditional approach to biomedical impact is a model based on the Cooksey Report and the two translational gaps. In UoA4 this is developed to include the spectrum of improved health determinants from individuals to populations; and strengths in biomedical, developmental and social neuroscience, as illustrated in the 9 selected case studies. The Cambridge environment offers strong support for impact. Good relationships exist with *Big Pharma*, notably GlaxoSmithKline (GSK) and AstraZeneca (AZ) locally and other companies elsewhere (Eli Lilly, Johnson and Johnson and Sanofi-Aventis); and with local Biotech (notably Cambridge Cognition). The University sits at the centre of a highly productive technology cluster; the 1500 local companies have a combined annual turnover of £11.8B and employ more than 53000 people with many connected indirectly to the University. For UoA4, the University partnership with associated NHS institutions, especially investments of the National Institute for Health Research (NIHR) underpin our translational research and its societal impact. Our main non-academic user groups and beneficiaries include: healthy people and the family; individuals with mental illness, the aging population, and diseases affecting the brain and spinal cord that together place an enormous economic burden on society; *Big Pharma* and Biotech companies; and people of all ages who show an ever increasing thirst for knowledge relating to neuroscience.

b. Approach to impact

Because the nature of our work is so varied, we need to have diverse and flexible approaches to impact, as set out below.

***Technology Transfer and links with industry*:** The University of Cambridge uses *Cambridge Enterprise* for technology transfer, consultancy and seed-fund services in support of local researchers, inventors and entrepreneurs. With partners, the University has established *Cambridge Investment Capital*, a technology company that provides follow-up on investments. Companies at different stages of spin-out from research returned in UoA4 include: licensing CANTAB software (Robbins and Sahakian) to Cambridge Cognition; behavioural control software and the design of touch-screen hardware for rodent testing to Campden Instruments (Bussey and Saksida); software to Lafayette Instruments ('monkey CANTAB', Cardinal); 'Whisker' control software (Cardinal and Aitken) and the CAM2 fitting method of advanced digital hearing-aids for hearing-impaired individuals (Moore) to researchers and manufacturers. There are strong links to the pharmaceutical industry. The GSK Clinical Unit Cambridge (CUC: directed by Bullmore [UoA4] to August 2013), with part-time secondment to GSK) is on the Cambridge Biomedical Campus and accredited as a Clinical Trials Unit by the Medicine and Healthcare Products Regulatory Agency. It specialises in innovative Phase 1 and early Phase 2 studies across a broad range of therapeutic areas, aiming to accelerate clinical application of promising therapeutic assets. The University of Cambridge expanded its links to GSK In 2012, with open collaboration to advance drug discovery. GSK has been the industrial partner for the Centre in Translational Medicine and Therapeutics awarded in 2012 to the School of Clinical Medicine with funding from the Wellcome Trust. In 2013 AstraZeneca announced the development of a new global R&D centre and corporate headquarters located on 11 acres of the Cambridge Biomedical Campus (£330M). This decision reflects access to scientific talent and excellent opportunities for collaboration with especially in clinical science: 'our proposed investment is a clear signal of AstraZeneca's long-term commitment to the UK and highlights the important role Cambridge plays internationally in bioscience research' (Pascal Soriot, CEO AstraZeneca). The focus of the new R&D centre will include disorders of the central nervous

system. A research agreement is being developed between AstraZeneca (MedImmune) and *Cambridge Neuroscience*, the community of brain scientists working in the Cambridge environment that partners 10 University staff (8 returned in UoA4) with 10 MedImmune employees working on neurodegeneration, with the aim of enhancing clinical translation. This collaboration emerged directly from an evening *A*cademia, *B*usiness and pharmaceutical *C*ompanies (ABC) event promoting collaboration and organized as 10 brain disease orientated discussion groups, co-hosted by Jeannette Walker (Liberty Property Trust and Countryside Properties plc) and *Cambridge Neuroscience*. Researchers returned in UoA4 are involved in the Innovative Medicines Initiative in the NEWMEDS project, with nine other *Big Pharma* partners led by Eli Lilly; and have led Phase 2 and 3 clinical trials programmes sponsored by Genzyme – a Sanofi company leading to a product licence for Alemtuzumab in active relapsing-remitting multiple sclerosis in the European Union. Funding from industrial sources is £4.59M in the review period.

***Translation into Clinical Practice*:** Translation into clinical practice is managed through an NHS/University partnership, to which the University attaches high strategic importance; the award of MRC Confidence in Concept funding (Franklin Aigbirhio); and the alignment of infrastructure provided by the NIHR and other funders to negotiate the Cooksey translational gaps (basic and clinical research to ideas and production; and introducing those products into clinical practice).

- **Cambridge University Health Partners**: CUHP is one of five Academic Health Science Centres (AHSC) designated by the Department of Health in 2009. The partnership between the University, Cambridge University Hospitals NHS Trust (CUHT), Cambridgeshire and Peterborough NHS Foundation Trust (CPFT) and Papworth Hospital NHS Foundation Trust focuses on the synergy between translational health research, education and service provision. CUHP led the creation of the Eastern Academic Health Science Network (AHSN) that aims to adopt and spread health innovation throughout the East of England, supporting enhanced use of research-based evidence.
- **NIHR Biomedical Research Centre (BRC)**: CUHP was awarded one of five NIHR BRCs (2007-12) designed to accelerate translation across the first Cooksey gap, from laboratory bench to the bedside. In 2011, an international review panel concluded that the BRC represents the primary academic biomedical research resource in the UK, resulting in its renewal with a 50% increase in funding (to £110m for 2012-17). Three of 10 themes relate to activities in mental health and neuroscience returned in UoA4, as does the separately funded Biomedical Research Unit (BRU) in dementia.
- **NIHR Collaboration for Leadership in Applied Health Research and Care Cambridgeshire and Peterborough (CLAHRC CP):** the CLAHRC CP focuses on translation at the T2 gap, aligned with earlier phase neuroscience and mental health research in the BRC. Hosted by CPFT, it forms a collaborative partnership between the University of Cambridge and a consortium of NHS, Local Authority, voluntary organisations and industry. Recently renewed (2014-18; £9.97m) with an extended remit for the East of England and in partnership with UEA, the CLAHRC is led by individuals returned in UoA4.
- **NIHR Healthcare Technology Co-operative in Brain Injury:** this was established in 2013 to catalyse NHS 'pull' for new medical devices, healthcare technologies and technology-dependent interventions into practice both nationally and internationally. The focus is on head injury and other research returned in UoA4.
- **The NIHR Clinical Research Networks** (and hubs hosted in Cambridge): the NIHR BioResource including leadership of the national 'NIHR BioResource' and the Wellcome Trust Clinical Research Facility, adjacent to the GSK Clinical Unit, provide infrastructure that supports translational research. Their juxtaposition and collaboration in Cambridge have lead directly to the acceleration of ideas and research across the translational spectrum, enhancing and accelerating their impact. These resources are used by staff returned in UoA4 for studies of head injury, multiple sclerosis, stroke, mental health and learning disability.

***Translation into law, policy and NHS practice**:* a number of researchers returned in UoA4 have prominent and long-standing advisory roles with Government departments, think-tanks and organisations such as NICE (chair and membership of Guidelines committees) that influence policy, practice and the law. This brings their own and other research findings directly into these

arenas. The Cambridge Centre for Science and Policy hosted 67 meetings between members of UoA4 and UK Government and the European Commission during the review period). We participated in several MRC (neurodegeneration) and Technology Foresight (mental capital and well-being) Advisory Workshops. Grants were awarded directly from Government departments; for example on 'design and validation of a situational judgement test for recruitment to the UK Foundation Programme' (David Good: £900k from the Department of Health).

Engagement with lay societies and patient groups: Involvement of patients is important in orientating and maximising the impact of our health-related research through involvement in the research process and the dissemination of results. The NIHR CLAHRC works closely with INVOLVE, incorporates the service user advisory group and has maximising user and carer influence on translational research as a theme for 2014-18 (http://www.clahrc-cp.nihr.ac.uk/). Many clinicians returned in UoA4 regularly discuss research with patients at meetings of lay Societies. We host interactive conferences for people with particular disorders; send out news-sheets; and maintain websites that present research finding in an accessible format (for example: multiple sclerosis [http://www.colescambridge.org.uk/]; Parkinson's and Huntington's disease: [https://sites.google.com/site/thebarkerlab/]; acute brain injury: through Headway (http://www.headway-cambs.org.uk, the Evelyn Community Head Injury Rehabilitation Team and a former patient (http://www.sciencemadesimple.com). We host open interactive events to cross-fertilise our research with public opinion; and are especially involved in public meetings for people with dementia. Patients with attention deficit hyperactivity disorder and obsessive-compulsive disorder spoke by invitation at 'Let's Talk Neuroscience' during Brain Awareness Week 2013 (Wellcome Trust funded); and at a related event held during the 2012 Cambridge Science Festival.

***Public engagement and Cambridge Neuroscience*:** A wide range of public engagement activities are undertaken by scientists returned in UoA4. We use press releases from the University (111 items listed on http://www.cam.ac.uk/research/news/); participate in science and literary festivals locally and elsewhere (e.g. Cambridge, Hay and Cheltenham) and other opportunities for increasing public awareness. Fundamental to our approach to impact has been the establishment of *Cambridge Neuroscience* as the voice of all that relates to neuroscience within the City of Cambridge. This was the first University inter-School Strategic Research Initiative (2004) founded on internationally-recognised research expertise; it connects fundamental biological research with biomedical, clinical or other disciplines and is well-placed to enhance impact and bring together key players with the goal of facilitating innovation on an international scale. *Cambridge Neuroscience* is managed by a full-time coordinator acting as a point of contact for: specialist Societies; identification of 'experts' for comment on neuroscience news items, and events; Cambridge Enterprise; Cambridge Science Centre; the Office of Communications and External Affairs / Media Representatives; and in providing help and support to its members in finding collaborators, sponsorship and support for different groups and clubs. A searchable directory currently containing research profiles of 751 Cambridge neuroscientists, including 291 principal Investigators links research to public engagement and news sections (www.neuroscience.cam.ac.uk); receiving c10000 visitors per week; with 294 relevant news stories pertaining to UoA4 documented between 2008 and 2013 (http://www.neuroscience.cam.ac.uk/news/archive.php); and collectively hosting over 2200 seminar series and lectures since 2008 (http://talks.cam.ac.uk/show/ index/6028). *Cambridge Neuroscience* sponsors many public engagement activities:

- ***Naked Neuroscience***: *Naked Scientists* is a multimedia initiative in public engagement with science that includes the award-winning weekly one-hour audience-interactive BBC Eastern Region science radio programme (syndicated on 5Live), targeting the general public. With support from a Wellcome Trust Society Award, Hannah Critchlow (*Cambridge Neuroscience* coordinator until 2011) has developed the associated '*Naked Neuroscience'* Radio and Road Show, supported by *Cambridge Neuroscience.* The 'Open Your Mind' interactive part of the road show has been delivered to over 8500 students (GCSE and A Level) at over 65 schools across the UK. Twelve Cambridge neuroscientists have contributed to the *Naked Neuroscience* podcast series, launched in December 2012.
- **Cambridge Café Scientifique:** *Cambridge Neuroscience* works closely with this national, MRC-sponsored scheme hosting informal monthly scientific debates with the public. Sixteen

members of *Cambridge Neuroscience* have contributed since May 2010. Podcasts and vodcasts are recorded by the BBC radio show and science podcast broadcasters (http://www.thenakedscientists.com/HTML/podcasts/specials/cafe-scientifique/).

- ***Cambridge Neuroscience* Public Lecture:** the Cambridge Science Festival held each March in Cambridge, is the largest free science festival in the UK, attended by around 50,000 people; members of *Cambridge Neuroscience* hosted 10 events in 2013 (http://www.neuroscience.cam.ac.uk/news/article.php?permalink=b2be349150).
- A public lecture is sponsored as part of the integrated Brain Awareness Week: in 2011, 'Brains, minds and their connectivity' (Bullmore) including a live twitter experiment illustrating how different networks share many key organisational principles; in 2012, 'Light, clocks and sleep: the discovery of a new photoreceptor within the eye' (Foster, Oxford) streamed live over the Internet in conjunction with the BNA (http://www.neuroscience.cam.ac.uk/events/ stream.php); and in 2013, 'Brain Machine Interface (Millán, Lausanne).
- **Smarter UK**: this is a Wellcome Trust funded facilitated classroom debate for 13-16 year olds that explores the ethical implications of using drugs for cognitive enhancement. Smarter UK, is organised by Graphic Science in association with *Cambridge Neuroscience*, and is currently being rolled-out in 9000 schools across the UK. In Cambridge, sessions are delivered by experienced science presenters, joined by *Cambridge Neuroscience* researchers (14 were trained in public engagement by Graphic Science in December 2011) and with members of *Cambridge Neuroscience* always being present. The workshop has been delivered to 1500 students (60 sessions with 25 participants each) since January 2012.
- **Twitter:** Cambridge Neuroscience has an active Twitter presence with 5613 followers
- **Pint of Science Festival:** *Cambridge Neuroscience* took part in 'Pint of Science', a new science festival for the general public held in 15 different pubs in London, Oxford and Cambridge (organised by Claire Gillan) over three days in May 2013. Topics for discussion in Cambridge included the brain, the body, and biotechnology. Researchers from *Cambridge Neuroscience* participated in the 'brain' lecture series which took place at 'The Portland Arms' on Chesterton Road. This festival received BBC national coverage (http://www.bbc.co.uk/news/uk-england-22522359) and featured daily on BBC Radio Cambridgeshire Breakfast.
- **Wellcome Trust: Wonder- Art and Science on the Brain (2013).** Members of *Cambridge Neuroscience* contributed to the British Neuroscience Association 2013: Festival of Neuroscience performances and stalls attended by 5000 members of the general public.
- **Public Engagement Training:** *Cambridge Neuroscience* participates in the 'Rising Stars' course and 'Making Public Engagement work for you' that offer training in public engagement and educational outreach for undergraduate and graduate students and early career researcher through practical sessions focusing on skills and the generation of ideas.

The Psychometrics Centre moved to the University of Cambridge in 2008 and became a Strategic Research Network in 2010. It focuses on the use of new social media to undertake and accelerate the impact from psychometric analysis through, for example: 'myPersonality', a Facebook APP that has enabled over 6000 users to assess personality; 'Concerto', an open-source online adaptive test development platform; 'Preference Tool' (a website using the 'myPersonality' database in combination with 'Facebook Likes' to link online behaviour to personality; and youarewhatyoulike.com, a website that enables personality to be predicted from online behaviour. Cambridge Enterprise has enabled spin-off enterprises in the UK and abroad.

c. Strategy and plans

Whilst our case studies necessarily are based on activities that antedate the development of the approach described above, we expect our future research increasingly to impact on society - maintaining the wide range of mechanisms for maintaining an open interface with diverse stakeholders including public audiences, policy makers, the public sector and industry; and ensuring that our research remains useful to patients and brings economic benefits. This will include more productive partnership with Biotech and *Big Pharma* with increased awareness of the need to generate intellectual property and develop spin-out companies. We have submitted outline applications to the MRC-Mica scheme with Lilly (Robbins) for a basic to clinical translational programme to follow our successful participation in the Innovative Medicines Initiative NEWMEDS work. There are also plans to submit an application to the Wellcome Trust Strategic Award scheme

for a neuroimmunology initiative in psychiatry with J&J and GSK (Bullmore). We will remain alert to these and other translational funding schemes including the MRC Developmental Pathway and Developmental Clinical Studies Funding and the Wellcome Trust Seeding Drug Discovery initiatives. Several structures recently introduced already support these strategies:

- Establishing a Clinical School translational research office to assist investigators in their engagement with ethical approvals, CUHFT R and D procedures, the activities of Cambridge Enterprise, and interactions with funding bodies and industrial partners – all in the interests of assembling and maintaining a portfolio of projects suitable for industrial partnership.
- Establishing a location on the Cambridge Biomedical Campus for IdeaSpace, a University of Cambridge hub for early stage open innovation that already successfully provides space and resources to a flourishing community of innovators, entrepreneurs and advisors on the University's west Cambridge and central campuses (http://www.ideaspace.cam.ac.uk/)

d. Relationship to case studies

Our case studies are chosen to provide examples of social policy, the law and education; technology transfer and industrial engagement; and effects on NHS practice including drug licensing. They are drawn from a diverse list of options that is fully representative of our research themes. There are activities both in basic science and clinical medicine each of which impacts on society in terms of human health and wealth. We did not use work that has informed NICE and related guidelines since we found it difficult to disentangle our work from that of others also making contributions to those criteria; and because it is difficult to ascertain the impact of those guidelines following publication. We omitted all work, such as diagnostic criteria and biomarkers, where interest currently remains within the academic community as not yet constituting impact in the sense that REF2014 intends; research that has had impact exclusively in the media; and work that failed to deliver medicines from a promising research platform. We found the process illuminating especially in exploring the distinction academic and societal impact; and between peer-review and scientific publication, and evidence for impact from users that can be readily supported and audited. We have further enriched our understanding of the sequence in which funds are provided from the public purse or charities in order to generate high-quality research testing that work in the academic arena; presenting and explaining academically endorsed research to the public in terms that generate interest and awareness of the methods and potential for successful biomedical research, emphasising that the dividends from science are unpredictable; and ensuring that a proportion of this work engages with commerce and non-academic users so that, in terms of better healthcare for the nation and wealth generation in the life sciences, society sees a return on its investments. Against this background, our case studies sought to achieve impact across four main domains:

- **Medical and social policy**: 'From research into mental capacity to clinical practice via Parliamentary statute: informing and implementing the Mental Capacity Act 2005' (Holland); 'Assisted reproductive technologies and the family' (Golombok); and 'Neuroscience of reading and dyslexia: impacts on policy and practice' (Goswami)
- **Industrial applications**: 'CANTAB-PAL, a novel mobile application for detecting Alzheimer's disease and assessing therapeutic interventions' (Robbins and Sahakian); and 'Touch screen based cognitive testing for rats and mice' (Bussey and Saksida)
- **Clinical standards used in industry**: Measuring loudness: a new international standard with widespread industrial applications (Moore)
- **Clinical practice**: 'Using functional imaging to detect covert cognition in the vegetative state – mapping the translation from research finding to patient management framework' (Menon); 'Management and outcome of head injury and cerebrospinal fluid disorders: from experimental medicine to standard clinical practice' (Hutchinson and Pickard); and 'A highly effective therapy for active relapsing-remitting multiple sclerosis: from concept to drug licence' (Coles and Compston).