EPSRC

Engineering and Physical Sciences Research Council

EPSRC Portfolio Day

Neurodegenerative Disease

Ramada Manchester Piccadilly Hotel, Manchester

11 February 2010

Findings and Observations of the Independent Panel

Contents

Chair's introduction

This EPSRC Portfolio Day, devoted to Neurodegenerative Disease, was convened primarily to examine the health of the discipline in the UK: to identify strengths, gaps and opportunities, and any barriers impeding its development. It brought together researchers spanning many disciplines; it therefore also provided an excellent opportunity for networking and to engage in dialogue with EPSRC.

The scientific participants, 49 selected on the basis of an Expression of Interest, with a further 10 invited by EPSRC, were randomly assigned to one of five groups, chaired by Professor Peter Brown (UCL), Professor Anya Hurlbert (Newcastle), Professor Julie Williams (Cardiff), Alastair Reith (Director of Neurosciences, GSK) and myself. Each group conducted a strengths, weaknesses, gaps and opportunities analysis, with the help of supporting documentation, flip charts and computer assistance from a member of the EPSRC staff. Group Chairs then presented their findings to a plenary session. There was opportunity for more informal discussion over lunch. The afternoon session had a similar format, with each group considering threats, translation and training. Group Chairs again presented their findings to a second plenary session and there was an opportunity for additional comments from the floor.

Given the breadth of research represented and random panel assignment, the analyses from the five groups showed remarkable consistency. This report records our findings and provides data and opinion to inform the wider research community, funders and Government. As on the day, it is organised in a SWOT analysis – strengths, weaknesses, opportunities and gaps – followed by translation and training. The key messages of the day are drawn from the group analyses. This is followed by a record of our panel discussion and a summary of our overall conclusions and recommendations.

Cutting edge research very often happens at the interface between disciplines and faces significant challenges in not conforming to traditional academic structures and funding models. Neurodegenerative Disease is a case in point, and the UK research effort is testament to the strength of its research community in this and associated fields. I would like to gratefully acknowledge all who participated in the Neurodegenerative Disease Portfolio Day in Manchester: The enthusiastic researchers from all over Britain, the EPSRC staff who were efficient, courteous and most helpful and the Group Chairs and other Panellists who were engaged, insightful and excellent company.

Professor Peter Morris,

Chair

1. Introduction

On the 11 February 2010, the Engineering and Physical Sciences Research Council (EPSRC) held a Portfolio Day in Manchester to look at research related to the area of Neurodegenerative Disease. Neurodegenerative diseases are a varied assortment of central nervous system disorders characterised by the gradual and progressive loss of neural tissue or nerve cells. EPSRC Research Topics that are relevant to this day include: Modelling and Simulation, Brain Sciences, Neurodegenerative Diseases, Cognitive Science, Vision, Hearing and Other Senses, Artificial Intelligence, Drug Formulation and Delivery, Neural Computing, Materials Research, Signal Processing and Imaging.

The day's attendees were selected by submitting Expressions of Interest to attend the event.

A list of attendees is shown in Appendix 1.

This report gives details of the Portfolio Day and the panel observations.

Finally, Section 4 presents the key findings of the day and the panel's

recommendations to the community, research funders and the EPSRC.

1.1 Portfolio Day Objectives

The objectives for the Portfolio Day were:

- To bring together research communities in the area of neurodegenerative disease to allow networking opportunities and to promote dialogue and a constructive relationship with the Engineering and Physical Sciences Research Council (EPSRC).
- To gather and exchange views on the health of the discipline in the UK.
- To explore upcoming opportunities for the research area, and to learn of the key issues affecting the community.
- To provide baseline information, and achieve a consistent view of the research landscape, in order to inform portfolio management and future opportunities for the community and EPSRC.

1.2 Independent Review Panel

The Panel assembled for the Portfolio Day comprised the following:

Chair:

Professor Peter Morris - University of Nottingham

Members:

Professor Peter Brown - University College London

Professor Anya Hurlbert - University of Newcastle

Professor Julie Williams - Cardiff University

Dr Alastair Reith, Director - Neurosciences CEDD,GSK

1.3 Agenda

A copy of the agenda is shown in Appendix 2.

The day started with EPSRC introducing the programmes within EPSRC that provided the funding relevant to this day. The Chair, Professor Peter Morris, highlighted his and the panels expectations for the day.

The attendees were split into five groups to ensure that a spread of expertise was across each of the groups. Membership of these groups is shown in Appendix 3. The five groups, and the panel member leading each group, were as follows:

Group 1 – Professor Julie Williams – Green Group

Group 2 – Professor Peter Morris – Yellow Group

Group 3 – Professor Peter Brown – Blue Group

Group 4 – Professor Anya Hurlbert – Red Group

Group 5 – Dr Alastair Reith – Pink Group

Each of the five groups was led by a member of the panel and the groups discussed strengths, weaknesses, gaps and opportunities in the morning session, before feeding back in a plenary session their top 5 discussion points in each of their areas.

In the afternoon breakout sessions (in the same groups) there was a discussion of threats, translation and training issues related to their research area. Points from the afternoon discussion were then combined with the morning discussion to give a SWOT report from each of the five groups.

The translation and training discussions are presented for each group in Section 3 of the report.

The key messages to come from the five groups are highlighted in Section 4 and are followed by the panel's comments.

1.4 Panel Information

The Panel used the day's discussions, and the following data sources, to prepare their session reports:

Appendix 4: Data on EPSRC portfolio relevant to this area

Appendix 5: Bristol on Line survey of opinion from the attendees

Appendix 6: Bibliometric data

2. Morning session discussions - swot analysis discussions

2.1 Group 1 - Convenor: Professor Julie Williams

2.1.1 Strengths

Imaging – PET; MRI – innovation

Imaging and PET and MRI have we maintained our number one position? With the high costs and Institutes expertise is focussed. More innovative new techniques and therapy is needed. In MRI we were leading but are now behind the USA. We do have a wealth of expertise and top centres in the UK.

New Technology -EIT is a cheap technology (Electrical Impedance Tomography)

Combination of techniques – EIT and MRI/ultrasound

Imaging for diagnosis and technology development and prediction adds value to other studies. Drug development and imaging has an important role. Data sets (NHS records) right across the population needs to be optimised.

Chemistry – nanotechnology

Nanotechnology – nano particles for imaging. New nanotechnology innovations are needed to sustain the UKs leading position. This area has had substantial EPSRC investment. It is a UK strength and is internationally leading, top 4. The areas of research include Multi-step synthesis of natural products, Chemical Biology (MRC/Pharmaceutical). There is a good Pharmaceutical base in the UK, developing new nano particles research is near the top in the world and has huge potential.

Assistive technologies - independent, robotics

There are challenges supporting the pipeline from discovery to application. The areas of emerging strength include Robotic assistive rehabilitation, Independent living, keeping people in their home environment, Self-management of conditions, Cross EU projects, Build on hardware technology using ICT, Developing the clinical models for treatment and management of conditions. Civil engineering for infrastructures and transportation.

Modelling and simulation – includes systems and bioinformatics, clinical disease modelling

Challenges include more integration. A new strength is modelling and simulation and the potential through data sets. Bioinformatics has a very high standing worldwide. Clinically applicable models and processing and process systems.

Genetics

MRC and Wellcome Trust investment is at the forefront worldwide in the area of genetics in dementia this now needs to be exploited. Also new ideas to be followed up in other disease areas. The UK is leading in some conditions eg Alzheimer's. The EU is part of International collaborations is a strength for example in e-science data sharing and has proved a facilitator of large collaborations in this field.

Strong medical charities

Clinical research networks

NHS

Running clinical trials the potential has not been realised yet this includes running clinical trials, data sharing and coordinated work.

NIHR

2.1.2 Weaknesses and Gaps

Lack of funding

Neurodegeneration is under funded compared to the disease burden.

The structure of funding creates barriers a one pot approach is needed.

Costs of future research will be high in some areas such as imaging, large scale collaborative programmes. Basic research in disease mechanisms is needed.

Imaging Infrastructure – access and coordination

Imaging in other studies:

Mass large scale – technology availability/access

PET cost of (facility), Training/expertise, physicists gaps chemists, radio chemists, (MRC/NCRI).

MRI

Industrial background – commercial support for neurosciences; facilities for clinical trials in UK

Exploitation ability, translation/innovation is stifled as there is a lack of facilities to take into practice

Bureaucracy around animal research

Over zealous bureaucracy is hindering animal research.

Chemistry and chemical biology

Applied research funding for radio/medical chemistry for rare diseases and Drug/Medical orientated chemistry is too low. There is a need for integration of community to move to translation going from in vitro – in vivo (eg chemistry/biology interaction).

Pharmaceutical investment is leaving the UK. Large clinical trials are needed. However clinical trial and drug development is a long and costly process. The development of clinically compliant nanoparticles – overseas (translation focus). Career structure how to retain people in the UK.

Challenges: sustained funding for mathematical modelling disease. Modelling needs to be funded focussed group of people needed (Centre of Excellence). Modelling for disease state there is a funding gap, also for systems biology to Engineering Physical Sciences.

2.1.3 Opportunities

Maintaining strengths

The area is under funded relative to other conditions, which means a lack of funding for expensive techniques and for modelling diseases. Research is innovative on small resources. Research Council boundaries cause problems to academics obtaining funding eg Applied research eg radiochemistry. For translation research the routes to funding is unclear which impede the research. A 'one pot approach' is needed to solve these problems. Funding mechanisms need to facilitate large scale programmes. A long-term strategy is needed to ensure that there is funding for basic research, to fund champions in the area.

The NHS can be used for research as well as clinical trials; data linkage and access to large clinical data sets and patient populations. Access to equipment will need co-ordination of current infrastructure between hospital and research centres is needed.

Patient involvement there is an opportunity to develop user orientated products.

The UK produces innovative research eg nanotechnology applied to genetic engineering.

2.1.4 Threats and Gaps

Bureaucracy / regulations in the UK is driving research elsewhere

Losing ground eg Canada last in (assistive technology) invested in large focused centres in telemedicine (we have not done this in UK).

Not great at knowledge transfer. Small fragmented industry is a bottleneck. There are some issues around skilling academics to talk to industry. Fragmentation in Research Base and industry means that translation does not happen often.

Have not got medium sized companies the economic development of those companies is an issue.

NHS as research resource has not yet been utilised. NIHR addressing – multidisciplinary/skill based people – training people to go into specific areas. Nobody is training the people needed in highly specialist areas.

2.2 Group 2 - Convenor: Professor Peter Morris

2.2.1 Strengths

Neuroimaging

The UK is a world leader in Neuroimaging methods, with particular strengths in MRI physics (Nottingham, ICL), functional MRI (FIL, Oxford) and image analysis including multimodal approaches (Imperial, UCL, and Oxford). It punches 'above its weight' as evidenced by representation at international conferences and in the literature (papers published and citations are shown in Appendix 6).

MRI was ranked first by respondents in the Bristol on line survey.

National focus on dementia research

A funded national dementia strategy is being implemented, a Dementia Tsar appointed and new funding (NGW) is imminent for dementia research. Dendron networks are being activated, for example, the Interdem – go network for psychosocial interventions.

Neuro-'prosthetics and assisted living technologies for neuro degenerative disease

The UK has a policy to develop Telecare/telehealth in practice and is advanced in: devices and systems (bio sensing), intelligent information technology and augmented reality. It is also advanced in neural prosthetic device technology, including new materials for neural stimulation (Cambridge/Imperial), advanced optoelectronics (Strathclyde), electronic design (Imperial, Manchester) and is a research leader in neuro-prosthetic treatment (deep brain stimulation, retinal implants, cochlear implants).

IT

The UK has leading practitioners in large scale data management and data mining who have set standards in the field. There are strong EU projects on Artificial Intelligence and Neural Computing. Data infrastructures are potentially cross-cutting to many problem domains but applications tend to be 'siloed'. However, more open collaborative research groups exist in the UK compared with the US.

Nano-scale measurement and predictive biology

The use of micro fluidics (QCM), Atomic Force Microscopy (AFM) for nano-scale measurement of single molecules and next generation DNA sequencing technologies for single molecule sequencing.

Quantitative and predictive biology in protein aggregation.

2.2.2 Weaknesses

Translation of basic research to clinical practice

Basic neuroscience is strong, but its translation into clinical practice is poor. This is in sharp contrast to the cancer field. In large part this is due to the lack of good animal models and biomarkers.

Drug discovery in cancer proceeds in parallel with the development of biomarkers and clinical adoption is rapid. This should be an exemplar for neurodegenerative diseases.

Interdisciplinarity and networking

Networks are essential for effective development of new technologies - for example molecular imaging, where expertise for developing imaging probes and imaging technologies may reside in different disciplines – and especially for their translation into the clinic. It is true of IT which is computer science centric with poor industry involvement. EPSRC researchers are often unfamiliar with the procedures for ethical approval. There is an issue of funding where research crosses Research Councils.

2.2.3 Opportunities

New neurostimulator technology

There are opportunities for improvements in the design of neural stimulators, including radically new approaches.

Computational neuroscience

This is an emerging approach that is strong in the UK but as yet is underdeveloped.

IT

There are new opportunities in digital infrastructure and for incorporating UK strengths in IT, including: assisted living computing, fast broadband, DE hubs, new digital applications.

Radiochemistry

Radiochemistry is a strength area, but a leading opportunity in PET has not been fully exploited for neuroscience. Rather PET developments have been focused in clinical oncology.

2.2.4 Threats

Perhaps the greatest threat is the decision by major pharmaceutical companies to de-emphasize, or, in the case of GSK, pull out of the neuroscience field.

2.3 Group 3 - Convenor: Professor Peter Brown

2.3.1 Strengths

Genetics of neuro degeneration

Especially gene discovery

Neuroscience

Neuroscience and clinical neurology

Imaging

Imaging - Particularly in vivo, mostly in technique development

Other possible strengths

Computational neuroscience

Identification of drug targets

Invertebrate models

Biomedical devices

2.3.2 Weaknesses and Gaps

Overall, UK well placed in basic science rather than translation.

Unclear funding strategy at the interface between disciplines

A more coherent structure is needed, as well as vehicles to support coordination and interaction between disciplines. In particular, support for interaction been academics and clinicians.

Vehicles to support coordination and interaction between site.

In particular, support for interaction been academics and clinicians would offer opportunities for multicentres. Research Councils could expand support for international collaboration.

Support for commercialisation and translation

Better biomarkers

Molecular imaging and chemistry

2.3.3 Opportunities

Basic science strengths

Opportunity to harness basic science strengths we already have eg imaging and genetics that are not being fully realised.

Current healthcare structure

This represents an enormous potential opportunity for research, although infrastructure for large studies is missing.

Computational research

More computational research to enable better use of data and better prediction of systems. The UK should be well placed for this.

Brain – computer interfaces

The applied side, in particular, is not well represented in the UK.

Model organisms and the ability to manipulate these

Imaging of oxidative stress radicals lacking Biomarkers.

Model organisms – opportunity to manipulate. Potential for replacing more expensive models.

Effects of electrical and magnetic fields on cells/systems

Promoted by UK strength in biocompatible materials & novel biosensors. Very good magnetism basic science community in UK.

2.3.4 Threats

Clinical neurology

May be undermined, especially through changes in clinical training.

Funding

Possible less pharma funding and government funding in UK in future.

2.4 Group 4 - Convenor: Professor Anya Hurlbert

2.4.1 Strengths

As a preamble, it's important to note that the group expressed some concern over the term 'neurodegenerative disease' as the header for the day. It might seem too narrowly focussed on a particular type of neuro-related disease and might have discouraged participation from some of the relevant research community (those working on neurological disease that is not degenerative or on fundamental mechanisms that underpin understanding of disease or on technologies relevant to studying neurological function in general, etc). We emphasised that the term was chosen to highlight one important element of the EPSRC portfolio but not to restrict thinking and we encouraged the group to think around all biomedical neuroscience areas with a strong connection to the EPSRC remit. So perhaps the long-winded term 'EPSRC-relevant biomedical neuroscience' is a better one to describe the focus of our discussions. Below I shorten this to EPSRC-neuro.

Neuroimaging (MRI)

Overwhelmingly, neuroimaging emerges from the pre-meeting survey and from the day's discussions as a key strength in EPSRC-neuro in the UK. Evidence includes: UK citations; UK leadership in software packages for use in fMRI analysis (eg the Functional Imaging Laboratory at UCL invented and now maintains SPM, a freeware matlab based analysis programme used widely around the world; the Oxford FMRIB produces FSL, likewise widely used.) MRI developed at Nottingham. From early on, support from universities and research councils has been excellent for the field, and the UK has led in developments. There is a broad range of expertise in neuroimaging across the country, including clinical, physics, software, and basic neuroscience.

Looking to the future, the combining of different neuroimaging modalities, in particular EEG/MEG and MRI, or MRI and MRS, are likely to grow as a UK strength. The combination of brain stimulation and imaging techniques are also emerging as powerful tools, and the UK has the potential to lead in these areas. See opportunities section below.

The question now is: How does the UK maintain its world lead? See opportunities section.

Brain stimulation techniques

Techniques for brain stimulation range from surface-applied (Transcranial magnetic stimulation or TMS/Direct current stimulation or tDCS) to deep brain stimulation. All of these are emerging as strengths in the UK (eg several groups pursuing deep brain stimulation in the UK; Rothwell); others pursuing motor rehabilitation and prosthesis (Baker etc) but are still in relatively early stages. There is a terrific opportunity to combine stimulation and imaging techniques: eg TMS and fMRI; tDCS and fMRI. (Jon Driver's research in area of TMS + fMRI an example of a 'first' (Queen's Square)).

Cellular neurobiology

The UK is second or third in the world, with only the US and possibly Germany ahead in terms of advances in the study of neural circuitry at the cellular level. The lead comes both in terms of tools for studying neural circuits (eg cellular imaging; electrode arrays; 2-photon imaging) and advances in fundamental understanding (understanding the mechanisms underlying epilepsy, for example;

Gray/Traub/Whittington); computational modelling of neural networks (the Gatsby unit; Dayan/XX/XX). For example, one model (from the Birmingham group) can predict onset of seizures – but it is important to quantify that predictive ability.

The appeal of this approach is that it starts with fundamental science at a cellular level, which relies on cutting-edge, technically-challenging techniques that require engineering expertise in design of electrodes and cellular imaging devices, and computing expertise in analysis of large-scale data arrays – in other words, key EPSRC-led areas – and then goes to the highest level to the understanding and treatment of neurological disease. How can we reproduce this approach in other disorders? For example, will it work for schizophrenia?

Assistive technologies

There have been big advances in assistive technologies (both research and applications), for example, the obvious advances tend to be on the **physical / motor function** side, but there are existing strengths and great potential also in the area of **cognitive function** assistive technologies. A number of points raised address not so much weaknesses in assistive technologies, but gaps in research, development, and especially in translation of novel findings to applications. See specific weaknesses and gaps below.

Cognitive science

There are strengths in fundamental cognitive science (eg UCL, the MRC Cognition and Brain Sciences Unit in Cambridge), and specifically in building of models. These are partly built on the UK's historical world-lead in artificial intelligence and cognitive neuroscience, but also include simulation and modelling of complex individual and social behaviours.

Gaps as above: how to translate these research advances into applications, both in terms of assistive technologies for cognitive function (eg memory, executive function, decision-making, language) and in terms of simple and effective bedside tests for identifying the key areas where improved function would really benefit the patient's life.

Modelling

Strengths lie in neural computing, computing technologies, and computational techniques across a range of topics and disciplines.

Pharmaceuticals

Traditionally, the interface between pharma and basic research in the UK has been very strong in the UK. There is concern that the interface with pharmaceutical industry is declining, as the profitability of making new drugs is decreasing with the increasing cost from regulations. We need to preserve that lead.

Genetics

The UK is very strong in research on the genetics of neurodegenerative disease, including motor neurone disease (MND). Apply known technologies to other diseases eg MND. Strengths in basic animal science are key: eg mouse models of Alzheimer's disease are shedding light on the mechanisms leading to brain changes; the demonstration of alcohol-dependency in the genetically pliable c. Elegans worms may lead to understanding of human genetics of the disease.

2.4.2 Weaknesses

General weaknesses in progress on EPSRC-neuro research:

Barriers. There are barriers to getting funding from standard research programmes. Interdisciplinary research does not fit into the standard models which funders implicitly use in deciding whether to fund a project. That is, the funder has a perception of what constitutes appropriate research in an area: for example, the MRC 'wants' randomised controlled trials. But interdisciplinary research might not fit into the standard model.

Short-term vs. long-term. This might also be described as a difference between a short-term and long-term outlook. If the hypothesis is one which can be addressed immediately with a controlled trial, the outlook is more short-term. If the aim is to determine whether a particular innovation in assisting memory during personal navigation significantly improves quality of life for an elderly person, the outlook might be more long-term.

Also, longer-term solutions might require longer-term research, not an immediate short-term benefit. There is a need for both short- and long-term research aims and projects.

Patients & clinicians. There is a gap between scientific developments and implementation at the clinical front, both for clinicians and patients. Translation of scientific advances into the clinical domain needs to be more direct and fast, and should be driven by scientists. For example, user-friendly technology and computer usability needs to be put onto the health-care delivery front. There is a need to link clinicians, engineers and health sciences to learn more from each other. In treatment of MND, for example, there are gaps in development of communication devices.

Drug delivery and development. More to be done, still, for MND and other diseases.

Specific weaknesses in area of assistive technologies:

It is difficult to quantify where the need for assistive technologies is greatest. Neurological and psychiatric disease affect both the individual and the community. Likewise, the true cost of disease needs to be measured for both the individual and community and assistive technologies should be targeted on the areas where greatest savings would occur. We need to understand the relationship between feelings of wellbeing in the individuals and the ability to function in the community. Where is the true cost of disease for the community?

How do we make the link from models of *neural* function to models of *social* behaviour? There is a traditional focus on the physical and physiological deficits, which while not a weakness in itself (in fact, there are great strengths in this area), leaves a gap between the research strength in understanding of cognitive deficits and the potential applications to assistive technologies focussing on cognitive and behavioural improvements. Even in diseases such as MND where the physical is most obvious, there may be cognitive and emotional effects of the disease which are as debilitating as the physical impairment.

Also, there is a gap in research and technology addressing the non-dominant senses, eg proprioception and mechanoreception. Some people with neurological disorders may have great difficulties with maintaining their balance, for example,

and these difficulties may have a great impact on ability to pursue daily activities, as much as the more obvious direct motor disabilities. Some members of the group felt that assistive technology research should focus on these less obvious deficits.

It is difficult to explain and quantify the impact of the large advances in assistive technologies – how does one measure improved quality of life?

2.4.3 Opportunities

Brain stimulation and imaging techniques

- Growth areas include:
- Development of dense measurement technologies, eg DTI in MR systems
- Further development of deep brain stimulation
- Combination of stimulation and imaging techniques (eg TMS and FMRI; TMS and EEG; fNIRS and TMS; tDCS and fMRI)
- Techniques to deal with the massive amount of data that will emerge are necessary to push forward technological advancements in deep brain and whole brain measurements
- Modelling the relationship between whole brain imaging results and behaviour
- Development of new tools to image and measure neural circuits *in vivo*
- New techniques for imaging which bridge small scale studies of neural circuits to larger scale or whole brain imaging.

Informatics and models

Data

The development of new techniques for handling large amounts of data is strong in the UK. But new areas of growth with respect to data handling are:

- Joining of information sources, eg DNA banks and complex behaviour banks
- How to store and share information, eg in establishing new ways of sharing data there is a role for research councils
- Realistic analysis of brain imaging data (eg DTI; combined TMS/fMRI; dense measurement technologies) as above.

Models

Growth areas in development of new computational models include:

- Development of assistive technologies for cognitive function (and not just drugs)
- To get MEG used to its full potential, there is a need for development, distribution and maintenance of good, free software packages (modelled on fMRI software)

- Drug development- modelling needed for integration of different types of data
- Bioinformatics of biomarkers for major diseases, eg MND and Alzheimer's disease
- Complex systems modelling of disease and its interactions with interventions; phasing of diseases.

New avenues in informatics

Bio-informatics of behaviour. In order to implement models of social, cognitive and emotional function, and ultimately develop assistive technologies in these domains, we need large databases of human behaviour as individuals and in groups. There are good ways of collecting large amounts of data on what people are doing, enabling the construction of a database of behaviours, a behavioural repertoire (eg in recent science-art projects at Newcastle, GPS has been used to track overall mobility of different ages and sexes of individuals; body sensors; phone usage; another project monitors behaviour of bipolar patients to chart change from depression to mania); these methods should be implemented and the results fed into models.

Technology transfer between diseases

Successful technologies can be applied from one disease to another: eg tissue engineering, considered a strength in many other domains from cardiology to endocrinology, could be more widely applied to neurodegenerative disease to repair deficits by growing nerves.

Engineering clinical applications

New technologies could and should be made smarter and easier to use in the clinic. More effort and funds could be put into the design and development of new devices and technologies, in order to increase their efficacy in the clinical setting. The economic drivers have just not been there - typically, scientific developments lead to specialist devices appropriate for the laboratory, and further development to take them to the clinical realm requires a commercial model that doesn't fit reality – development into usable technologies requires more investment than can be recouped. But the technology then effectively remains untested, if it is not make science-led technology available/useful to clinicians.

Collaboration across disciplines (RCs)

There are opportunities for RCs to work together more. It is important for the EPSRC to maintain cross-disciplinary initiatives and to work with other partners. There is more scope for translation of research from EPSRC to NIHR, closing the technical to clinical gap. Health scientists need to measure the effects on patients, and feed information back to technical development teams.

Other areas to develop:

Stem cell technologies

Targeted delivery of drugs

2.4.4 Threats

2.5 Group 5 - Convenor: Dr Alastair Reith

2.5.1 Strengths

Neuro-imaging (MR, MEG, EEG)

Research base for MEG build up research capability there are now seven centres in the UK. Imaging more generally MR, MEG, EEG based institute of neurology. Most major universities have a brain imaging centre. The MS society has also invested funds in this area.

Fundamental neuroscience

Fundamental neuroscience well distributed across university sector. UK performs well and feeds into the strength in pharmaceutical industry. GSK have invested in a clinical imaging centre, located in UK due to UK capability.

Clinical neurology (cross-cutting)

Clinical neurology, there are centre's including around cognitive neuroscience. Funding in broad centre's under one roof from bench to translation – Sheffield CITRAN centre to launch 2010 is an example of this.

Medical engineering

Medical engineering is an increasing strength, and medical engineering centre's are leading the cross disciplinary approach. Systems engineering and biology centre's are also contributing to this strength.

Patient base allows the examination of clinical genetics, also has an impact on genetic screening having an impact on Parkinson's. This is not a broad strength but there are areas where this is developing. Linkages to clinical centre's is patchy and could be consider a weakness this area requires a clinical champion. Good ideas around diagnostics and surgical techniques but the hurdle is linking with clinical practices.

In the EPSRC space materials an important aspect biomaterials, scaffolds and tissue engineering. This is an emergent area rather than a UK strength. Pharmaceutical, biopharmaceutical and cellular interventions are currently individual activities and are not integrated.

Is neuro-informatics strong in the UK? This is unclear, and may be more of an opportunity.

2.5.2 Weaknesses

Access to clinical trial experts (eg through charities)

The MS society has developed a clinical trial network. Access to neurologists to recruit to trials a challenge and can often have access to 20-30 patients. The MS network allows much broader patient base. EPSRC may have a role in supporting similar networks.

Linkage to different technologies, multi-disciplinary teams/networks

Need a clinical champion for a particular methodology who has influence within their clinical centre is difficult but is an absolute requirement. If additional imaging. If additional imaging for example is required this can be an economic barrier.

Not just a single champion in certain areas will need global networks. For spinal injuries no linkages between centres and lack of capability for research support, therefore an international network required.

Not just a clinical barrier, assistive technology to support community based care also required. Social services in this case could be a barrier.

Access to raw data/patients (NIHR requires all data to be in public domain!)

Access to well characterised data and multi-modal data sets is an issue. The UK has strength in data analysis method but limited data pool therefore not appropriately trialled and does not go into wider use. Can get publications for piecemeal work often not rewarded for broader engagement. Often the researchers do not have the route to follow this up. Example of international dataset set up allowing people to join contributing 3-5 patients. Only well characterised data is able to contribute.

Unless the outcome measures including functional measures are correct at the initial stage then data not of use.

Validation between mechanistic and physical outcomes

Cost of late stage clinical trials – can use that phase 1 mechanism information to support case for later stage trials, understanding progression and the effect of intervention on progression. There is a need to identify where the treatment option windows are and when interventions are crucial.

Need to identify target and then pharmacology of particular compounds against that target. The best validation will always be in patients. What are the minimum number of steps that will be required? (Including animal models) to get to patients. Computerised models increasingly being used and then use a smaller number of patient data to validate that model.

Exercise and activity based interventions also small scale and often does not have clear outcomes measures, often simply jump to proof of concept stage. However these non clinical interventions do not have the same regulatory barrier but can have major impact on community based intervention and quality of life.

Health economics modelling

There is a need to tie up the physiology with the anatomy. Health economics should be integrated within projects. Return on investment on drug development

in neurosciences is risky. The main part of that risk is around securing late stage clinical trials (need cheaper and faster trials).

The dietary and nutrition aspects are unregulated but have great potential and therefore need to be considered.

Because of individuals, working in isolation there may well be duplication of research effort.

The time and regulatory issues involved in working with NHS is a barrier. Can work internationally for example in US, but local champion would be ideal and have additional advantages. NHS managers concern if the process becomes successful what would be the economic and operational delivery. Communications with healthcare managers is crucial. There is a variety of attitudes amongst managers on the benefits of being research active.

2.5.3 Opportunities

There is good capability and take up of Engineering and Physical Sciences Research. There is an opportunity to finding a champion to highlight the importance of the area.

Neuro-informatics

Charities – clinical trail experts (EPSRC opp6)

Demonstrating impact (NHS costs, run network)

Access at clinical end

Linkage – multidisciplinary/network different and chronologies (Blood Brain Barrier).

Data (eg access to raw data/patients NHR – all data public?)

Output measures (mechanism and function)

Identifying market (imaging –physiological (broader than imaging – eg clinic)

2.5.4 Threats

3. Afternoon session discussions – translation and training

3.1 Group 1 - Convenor: Professor Julie Williams

3.1.1 Translation

Funding balance

RCs should not move the balance from basic research the bottleneck is here for Neurodegenerative area so focus on translation premature when we do not know enough about the causes. EPSRC has made investments in Knowledge Transfer Activities eg KTAs - impact yet to be realised.

Good Examples

(1) Image analysis Software is freely available, this is a good business model.

(2) Compounds are being developed from Alzheimer's for alternative therapies.

(3) Steering fields in Deep Brain Stimulation.

Barriers

There is a lack of maturity of markets in non drug products such as personal care models and for AT there is no obvious route to market. There is a need to get industry/user collaborators/partners on board early on – not just a letter of support

Funding specifically from basic research to demonstrators/prototype is needed. Animal model testing finance is needed. Funding for higher risk projects is needed and funding specifically for translation.

Regulation – lack of clarity eg MHRA a better understanding of the area is needed.

More joined up thinking is needed to make connections between the Department of Health and Research Council innovation pathways.

Research Councils should make money available to facilitate translation eg Follow on Fund and Feasibility Fund to stop people falling between the cracks.

Translation Research should not be funded at the expense of basis research, we have put a lot of money into this but impact takes time. DTCs, KT Activities, Discipline hopping, Challenging Engineering are good activities that have encouraged people.

How to measure impact? It needs to be in REF to drive universities.

3.1.2 Training

Strengths

Good Training Initiatives: DTCs, Challenging engineering. These should be built on to facilitate movement of researchers between disciplines into areas of Neurodegeneration.

Issues

Lack of highly specialised people for imaging specifically radiochemists.

Closure of Chemistry departments, MRC Cyclotron, Health and Safety. Highly specialised people eg radio chemist – Need more than three fellowships. There is a lack of senior radiochemists' at universities to build up research groups.

Health and Safety regulations a licence is needed to maintain laboratories which leads to a perception of it being a dangerous area. MRC is withdrawing money from cyclotron unit. Companies snap people up and pay more.

Capacity building - especially in basic sciences and translational in neurodegeneration.

Career paths the interface between NHS and Universities. Keep both options open at the moment they have to do one or the other.

Leadership and fellowships – training in industry liaison, Translation fellowships.

Need industry and universities and NHS to discuss career pathways.

Open and clearer career paths: academia/NHS/Industry. Need to capacity build across the board in this area in clinical and non-clinical.

PhDs and fellowships.

Are the current chemistry PhDs and DTCs covering the neurodegenerative disease area? Are neuroscientists going into the neurodegenerative area?

Training/funding to facilitate this – stem agenda – decide pre-degree.

Discipline hopping awards could be used with year sabbatical in another laboratory to encourage mobility between areas. There is a need to educate non-specialists in what is needed in the neurodegenerative area.

Open and clearer career paths: academia/NHS/Industry. Need to capacity build across the board in this area in clinical and non-clinical.

3.2 Group 2 - Convenor: Professor Peter Morris

3.2.1 Translation

Continuity of funding - retaining skills

Funding for different aspects and programme stages often comes from different funders. Sometimes, the research falls in the gaps between what is supported by different research councils, and there is failure to agree on how it should be supported. This has been the case even for fields in which the UK is world leading, such as image analysis. Some funding schemes eg the follow-on fund are too restricted. The small overhead in FP7 is a deterrent, but it is possible to use this to leverage additional funding.

Referees tend to favour core disciplines and are less supportive of more applied research. This could be addressed with cross disciplinary referee pools. There is a lack of continuity in funding and this is a serious threat to skill retention in groups. If we want to compete effectively on the international stage, this is likely to need wider collaboration and be output driven.

Attracting company collaboration

There are barriers to industrial collaboration, including the timescale of collaborative research which is protracted because of the time to secure grant funding – waiting for deadlines, time to decision, etc and Intellectual property issues with some university technology transfer officers unrealistic in their expectations and the need for open publication of PhD theses (though this can usually be delayed). NB EPSRC allows open disclosure of work it supports.

Attracting company collaboration is mutually beneficial. Companies can often offer help with eg ethics and statistical analysis, and in return receive exposure for sales, easier patient access, etc.

Fragmentation of research

Expertise is spread out across universities; it is hard to establish the right networks and administration is difficult. Help to develop collaborations with leading people and to develop the right packages would be useful (eg KT–EQUAL project).

Translation to clinical neuroscience

Translation to clinical neuroscience in practice is very poor at the end point of the process. This may be improved by greater awareness of clinical need on the one hand and scientific opportunities on the other that could be met with targeted conferences in the field of neurodegeneration.

3.2.2 Training

Interdisciplinary PhDs

There is a significant mismatch between the interdisciplinarity required for research and subject specific education that is the norm in UK academia. In particular, there is a disconnect between physics and clinical departments in many universities. This leads to shortages in highly skilled personnel, even in areas where the UK is strong, for example MR physics. There is a need for specific training programmes which could be across multiple sites. Masters before PhD programmes require more than three years and interdisciplinary PhDs need to develop a wider skills set; this needs longer PhD/grants or equivalent CDTs in neuroscience and flexibility in doctoral training and grants.

Different studentship strategies have been used by the research councils. These should be harmonised; the “integrated PhD” model is a good one.

Eligibility for international students

Eligibility for some studentships could be widened: in some disciplines there are good overseas applicants, but it is hard to find good UK students. This is especially a problem as many overseas scholarships have disappeared. There is a need to promote interdisciplinary research amongst school and undergraduate students in EPS areas.

Lack a research-only career path

Career progression means that it is hard to focus on research. This is exacerbated by the reduction in the number of research fellowships, and high teaching loads.

3.3 Group 3 - Convenor: Professor Peter Brown

3.3.1 Translation

STRUCTURAL

Small fragmented groups

It is difficult to bring research groups together. There is a need to encourage cohesiveness and coordination between groups; eg networks, Centres of Excellence and early clinical input should be encouraged, aided by funding to realise integration and fund joint students. The link between academics and clinicians needs to be supported with a two way information flow and a change in operational culture.

University system inhibits movement between disciplines

University structures impede discipline exchange. A solution to this is to have [a] parallel structures, eg networks or Centres of Excellence and [b] funding for feasibility studies to bring people together and overcome initial barriers.

Funding to take research from concept through to translation

There is a need for pull from applications side rather than just push from basic sciences to achieve translation. Junior academics are often at the translational interface and their role needs to be recognised. Senior university colleagues may need to be educated on the benefits of this approach as this has impacts on career structure and needs to start at undergraduate level.

Coordination of cohort trials at national level

Funding support for organisation of large cohort trials.

PROFESSIONAL

Risk aversion

Particularly where research crosses disciplines. Reinforced by nature of peer review.

Data Sharing

There is also an aversion to data sharing where it would be worthwhile eg transcriptional data bases. Need structures for the managed & controlled data sharing, including ethics. Tendency towards less communication and more competition. Sharing necessary in terms of setting up national level projects

SOCIETAL

The ethics of prospective databases

Eg MRI, biomarker databases, at risk registers etc.

Non-human primate research

For example, transgenic marmosets could be very useful for drug screening etc.

3.3.2 Training and Skills

Broader early and late training

Solutions? 4 year PhDs in which the first year involves much more of a multidisciplinary element, Summer schools, MSc courses, funding for more than one PhD in targeted areas.

More realistic discipline hopping grants

(One year is insufficient)

Imaging orientated chemistry

Recover drive for research in medical training

Loss of pre-consultant researchers

Loss of emphasis on research in medical training

Combined honours degrees

Continued education programmes eg summer school in neurodegeneration

3.4 Convenor: Professor Anya Hurlbert

3.4.1 Translation

This is a two way process and a mechanism to encourage exchange between Clinicians and Engineers/Scientists in both directions involving industry where possible, is needed at early stages of research. Charities focussed on particular diseases can facilitate the conversation, with their specific awareness of practical patient needs. The key need is for clinicians and engineers to understand better what the user's needs are; time is needed and networking money needed to enable the 'show and tell' meetings between all the sides involved. Industry should be pulled in early. The need is for "clinical pull, not just science push".

Therapists know what they want but don't know people/technology to get this to happen. Clinicians may not know what patients want on a practical level in dealing with a disease. How do you identify problem areas?

Translational development of assistive technologies/devices is hampered by lack of methodology for identifying need. This is an important research question and different from problems facing pharmaceutical development.

Devices translation is different to drug development.

The drug company model is highly regulation-driven. Basic research leads to identification of specific target molecules, particular type of product, which is then subject to testing and approval before marketing. The company that developed the drug is invested in pursuing the approval; only one company will "win" with its product.

Devices-development follows a different path. Basic research is necessary to identify first the type of intervention necessary. Efficacy, acceptability and commercial viability are all questions that need to be considered at early stages, but the latter (commercial viability) is not the key driver, and in some cases, not necessary.

Devices regulations driven down this model

To define the Research questions there is a need to work with users to develop the questions, and the needs. The Methods to do this do not currently exist and need to be acceptable to patients/clinicians.

NHS processes

NHS processes are lengthy and there are restrictions on funding industry/companies. Questions the use of technique – novel interaction between clinician and technology.

Biomarkers

We need better biomarkers. There are long-term issues on how we monitor disease and the efficacy of drugs. Monitoring biomarkers of disease as a way of monitoring efficacy of drugs is important, and will impact on drug design.

Will the technology be cheap and effective?

Pharmaceutical economic models are going through intensive evaluation and change – even perhaps a 'crisis.' Pharmaceutical companies are now outsourcing to academics in the Far East.

Summary:

Product – what is this? A new animal model? Process? Drug? There will be a different challenges for different products.

A high investment is needed to take a device to product but it won't make income of a drug.

Charities

The Charity Sector can facilitate discussion between clinician and researchers

Service provision tailoring across multiple providers is needed with Holistic care across a number of professions and specialism's.

Charities can facilitate research but this depends on the charity size. The funding landscape for neuro-diseases consists of many smaller charities which are not as effective as single large charity as in the area of cancer research (CRUK). We need to look at possible collaborations, such as between MRC/Dendron.

Scale of Market

Industry needs to be involved at beginning to influence development eg find other markets and other applications to expand market. For many neuro-diseases the key interventions may lack commercial viability. The scale of market needs to be researched. A niche product costs the same to development if they sell 10 or 1 million. What is the commercial viability of products than may only work for a small percentage of people? Health economics/quality of life calculations to measure value for money are needed.

The EPSRC can play an important role in identifying the right company to pursue new technologies for intervention and assistance, through Technology/Knowledge Transfer networks, eg.

3.4.2 Training

People with clinical technical skills are needed to "bridge the gap".

Clinical/Technical skills to bridge gaps are needed not just for doctors but for health workers and nurses.

MD/PhD programmes in the US enable closer working between clinician and engineers in different settings. Discipline hopping can help overcome cultural barriers. Engineers training to become medics (or vice versa) (eg the Medical Engineering Medical Physics (MEMP) programmes in the US) is becoming more common but more of this is needed in the UK. More need for MD PhDs/MEMP. It is also important that after clinical training for engineers and scientists there is a range of jobs available – currently, the perception is that the range is small. Training programmes needed to address the gaps.

For later career stages, discipline hopping is also important. Aim to enable clinicians to have training/work in an engineering department. The challenge would be overcoming cultural barriers and a perceived obstruction to career paths by the clinicians. For discipline hopping in the other direction, there is the barrier caused by the perception of some physical scientists/engineers that they are 'looked down upon' by clinicians.

There is a strong science base in neuroscience that does not readily translate into pharmaceutical or other translational applications. There is a need to train translational neuroscientists.

Possible solution is intensive component of translational training during PhD. Need strength in physics, chemistry and maths in students. Doctoral training centres (DTC) are a good model.

There is a lack of biology training in the Medicinal Chemistry Interface. More biology expertise is needed in training in pharmacy schools and in drug design.

Imaging Centres - Training in both disciplines, physics and biology, needs to be formalised.

New Skills

Short courses/continuing Professional Development are important to introduce new areas to already trained professionals. The courses that work best are very targeted and/or intensive (eg one week in the current state of art of neural research). More are needed. It will be challenging to get all parties together make the event relevant to all.

IP issues may be a barrier to collaboration.

3.5 Convenor: Dr Alastair Reith

3.5.1 Translation

Regulatory approval/funding in NHS (easier in US)

Regulatory approval funding in NHS (this is easier in USA). LDAs (slow) institutes technology transfer. There is a funding gap, Venture Capital, Charity culture, and UK Government/EU.

LDA and TTOs – very slow

Universities can be risk averse to entrepreneurship. What is the level of support in institutions? This has improved but Regional Development Agencies (RDA) and Technology Transfer Offices (TTO) can be less helpful. Better informed academics to decide the best route forward rather than simply handing it over to TTOs is needed.

Charities in the US set up to support research in companies even trans-nationals. The culture of UK requires changing. The research funders could bring together parties to identify the appropriate routes forward.

Funding gap: venture capitalists, charity culture, UK Gov/EU

Possible solutions: Improved understanding, Roadmap – all key players in pipeline, KTP – for clinicians

Solutions could include a Roadmap with all key players in pipeline would help understanding in the community, Clarity of purpose – publics – for h/c public, and Multi-centre NHS/CRFs – engagement

Multicentre

Engagement with NHS/CRFs

Knowledge Transfer Partnerships for clinicians could be useful.

Barriers to translation include structural, professional, and social acceptance.

3.5.2 Training and Skills

What are the skills needs in the UK? Good existing multi-disciplinary teams within/between institutions eg Centres for Doctoral Training.

The overall strategy should be to have exposure to clinicians and other research areas. Funding is an issue both to bringing in infrastructure and PhD support.

What skills do we need in the future?

Can a large number of disciplines lead to an individual being isolated? They may still need to be able to collaborate with academics from within their own discipline. This can be overcome through workshops and seminars open to all. Bridging the gaps can also help.

A challenge can be fragmented individuals within group, but with effective team and project management this can be overcome.

We need to understand lab bench clinical issues, gaps include clinical research, Radiographers/imaging, Pre-clinical imaging, Career route beyond PhD, Commercial eg medical devices to be retained in the UK. Students have to tackle

issues of clinical need. In Plymouth a project had a PhD and a MD working on the same project sitting in the same laboratory. The outputs are now in hospital use. Good existing examples of effective working. The best clinicians will want to focus on clinical practice. Gaining an MD can be difficult to move back to becoming a consultant.

Skills gap in clinical research, radiographers/imaging, preclinical imaging. Career route beyond PhD: commercial eg medical devices, Retain in UK.

World leading in imaging; however, there is a lack of clinical research radiographers and preclinical imaging individuals.

Post-PhD career route beyond graduation the medical device industry not UK based and therefore UK will lose trained individuals.

4. Key messages from the day

4.1 Break out Session 1 (Strengths Weaknesses and Opportunities) and afternoon (Threats) discussions

Strengths World leading combined MRI/PET [strength at risk] Fundamental neuroscience [cellular neuroscience] Genetics are very strong – limit strength to gene discovery [opportunities think about genetic manipulation?] Strengths – what do we have to do to keep them there?	**Weaknesses** Lack of funding in relation to disease burden [health/social/economic] – costs. This area needs research to identify where the key burden is. Funding for interdisciplinary research [Molecular imaging – goes in with biomarkers] – need for better biomarkers Bureaucracy animal models – barrier to research – there are opportunities Gap in world knowledge – lack of animal models Unclear strategy around multidisciplinary research funding A need to support coordination between academics and clinical – between sites and international collaboration. There is a gap for multisite collaborations – at institutional level encouragement to stay local. Transatlantic should be specifically pulled out. Lack of desire to send UK money to US [perceived as rich].impossible to get this funded.
Opportunities Computational neuroscience [opportunity with regard to neurodegenerative disease] and signal processing and informatics Computational modelling Neural Engineering combining imaging and stimulation technologies Networking/linking clinical centres with RB and exploiting the power of NIHR/NHS for research Development of assistive technologies – Important to emphasise the cognitive aspects.	**Threats** Clinical neurology [strength at risk] and cognitive science Pharmaceutical sector is strongest – real concerns about the movement of Industry R&D – commercially driven decision around risk. Who is going to pick up on risk? Weakening PET danger

4.2 Translation

Key messages:

- Pre-clinical imaging
- Continuity of funding from concept to translation this can mean applying to different Research Councils (RCs) [and the proposal becomes less attractive to RCs as they appear more incremental]. Would need to blend with – what's the point of translation
- What is the purpose 'of translation' is it to get more publication? Are the metrics correct? They also change as move along the pipeline. Are they same as for industry? This may be an opportunity [biomarkers are a common need and could have academic led consortia] to support the general area. The funding pipeline will need to be agreed by RCs/Charities/NIHR/payer. A Technology Strategy Board for healthcare is needed
- IP issues – ownerships sometimes impedes the grant – university issue?
- The groups are small and fragmented with expertise spread across universities and some falling between gaps. Can we bring them together? To encourage cooperation and get community together to identify opportunities which would encourage bids.

4.3 Training

Key messages:

- PhDs – interdisciplinary areas takes longer – support for longer PhDs/MSc-PhDs – or duals PhDs? MD/PhD – eight years. The outcome is fantastic people. Engineers go into medicine
- Models such as the DTC and Engdocs.
- Discipline hopping – not long if really going to change discipline? But flexible hopping between disciplines – [eg Leverhulme]. Talk to MRC about MD-PhD. Hard to get people across engineering like you can in the US [where is engineer – would be hard get people to do that]
- More strong international students appearing [fewer domestic ones]. Funding issues around this – already raising this with BIS
- Lack of research only career path – particularly if in one of the interdisciplinary areas. Inclusion of a more translational year would help with getting more applied knowledge into academic neuroscience
- Part of reason for the decline within PET above [closure of chemistry departments]
- Part of basic neuroscience PhD – four year one and one year on translation.

5. Panel discussions

Strengths

Fundamental neuroscience [cellular neuroscience]

Genetics are very strong in gene discovery there are opportunities to think about genetic manipulation.

World leading in combined MRI/PET [strength at risk]

Clinical neurology is a strength which is at risk.

A strength which is at risk, is the pharmaceutical sector where there are real concerns about the movement of Industry Research and development activities and commercially driven decision around risk in this research area. Who is going to pick up on risk? Lengthen costs of clinical trials and risk. Positive way forward the community needs to find answers about the strength at risk. – speak to Alasdair about this! Difference between UK based company.

Weaknesses

Molecular imaging is a fashionable area but there are not very good examples available (mechanism biomarkers) there is a need for better biomarkers.

Bureaucracy is a barrier to research and translation and one reason for the lack of animal models which is a world wide gap. There are opportunities in modelling disease.

Collaboration

There is a need to support coordination between academics and clinicians, between UK sites and for international collaboration. There is a gap for multisite collaborations at an institutional level there is an encouragement to stay local. Transatlantic collaboration is harmed as there is a lack of desire to send UK money to US [which is perceived as rich] and so it is not possible to get this funded.

Pre-clinical imaging infrastructure

The availability of pre-clinical imaging that is needed for translation is currently limited in terms of access and time on equipment. Not many places to do research now research fits within academic departments.

Funding Strategy

There is an unclear funding strategy at the interface between funding disciplines. There is a need to support coordination between academic and clinical researchers at and between sites with international collaboration as expertise in the UK is spread across institutes with small fragmented groups and some falling between gaps. Can we bring them together in a sensible way to compete internationally with very large international groups? Cross University collaboration is not currently encouraged. A virtual network consortium could encourage cooperation and get the community together to identify a small number of priority areas/projects and then encourage bids. Link clinical centres to academic harness power of NIHR.

Disease Burden

There is a disproportionate amount of funding in relation to economic burden of disease (put in costs ART report). We do not currently know the true cost of disease for the community. What is critical area for community to reduce the real burden of disease? Research into understanding the burden of diseases is needed. Refocus research priorities by appreciation of disease burden.

Opportunities

Emerging / opportunity / at risk: Neural Engineering

Neuroprosthetics/TMS/interface neural tissue

Biomarkers used as outcome measures. How do you measure in a clinical setting what methodologies can test the efficacy of mechanism of action with sensitivity that is also robust.

How do you measure behaviour, tacking people? All could feed into biomarker that could help with progress of disease and help with treatment. The right measurement techniques for behaviour need to build in mechanistic imaging?

Scenario/function mechanism can be coupled with strengths? How do you encourage people to do this? Build up networking and clinical knowledge transfer hooking up patient populations around imaging.

Networking/linking clinical centres with the research base and exploiting the power of NIHR for research. There is an opportunity to influence [NIHR] dynamic research on population based/ patient cohorts research. Discussion point in this section. The NIHR is trying to address translation gap. Networks such as Dendron and the brain bank initiative are resources that could help to do this research.

Huge opportunity in taking computational modelling and informatics and applying to research

The combination of imaging and stimulation technologies is an opportunity for diagnostics and interventions, examples include [TMS/MR] where there are existing pockets of strength. There is a need for early interaction basic scientist and industry when developing these imaging techniques. TMS is very important as a research tool. Direct Current Stimulation (DCS) is useful as a basic research tool but not a successful therapy replacing ECI.

There is a computational neuroscience network in place.

Targeted drug delivery, bio-therapeutics and stem cells, the link to nanotechnology should be made. Ultrasound techniques in bubbles for drug delivery have been developed. There are some key firms in the UK some small pharmaceutical firms that have been good in drug delivery in the UK. The technology is getting to the stage where it can do some good.

Predictive biology [microscopic measurement techniques]

Neural engineering

How to measure outcome measures in a clinical setting methodology, efficacy of action must be robust. Where biomarker? Molecular behaviour, how to measure

behaviour, biomarker to identify disease and as target for treatment. Behaviour modification is the ultimate aim- clinical trial- noise in these- FDA function not behaviour – but need to relate.

Threats

Weakening PET danger the decline this includes the closure of chemistry departments.

Training

Training in Interdisciplinary areas takes longer therefore there is support for longer PhDs/MSc-PhDs or duals PhDs? For example MD/PhD which take 8 years. There is a real need and real win from this training model which could enable engineers to go into medicine, as it produces excellent people.

Discipline hopping grants are not long if people are really going to change disciplines? But flexible hopping between disciplines like the Leverhulme scheme would be useful. Also EPSRC will need to talk to MRC about MD-PhDs. Will it be hard to get engineers to do this scheme in the UK?

There are more strong international students appearing and fewer domestic ones there are funding issues around this and it is already on the agenda at BIS.

There is a lack of research only career path for clinicians particularly in the interdisciplinary areas. Including a more translational year would help to develop these skills that are currently missing this could be included as part of basic neuroscience PhD.

Translational

The continuity of funding which would allow translation of basic research is difficult to obtain as funds have to be sought from different research councils. As the applications become more translational then they become more incremental and referees are harder on the research quality. Blend funding gaps before research becomes attractive for Venture Capitals funding. Funders/Researchers need clarity of purpose? Is this to get more publications or for healthcare impact. This balance should shift as the research moves from basic research to translation. There is an opportunity for companies to work in partnership (a number of companies) academic led consortia easier than industry with general funding for consortia and opportunity for more specific funding. A funding pipeline across research councils/industry/charity is needed. Healthcare provider buy in is essential (NIHR) a translational council is needed a TSB in other research areas.

Intellectual Property (IP) issues are usually university issues with unrealistic expectations of IP. What is the purpose of academic researcher? Supporting companies is seen as bad by peer reviews? Incremental research can often have huge impact.

6. Conclusions

The UK is strong in fundamental neuroscience and in gene discovery related to neurodegenerative disease. It also has strengths in clinical neurology and cognitive neuroscience, but these disciplines, particularly clinical neurology, are at risk. The UK is world leading in neuroimaging, especially MRI, and in image analysis, where it sets the international standard.

The UK has a strong pharmaceutical industry, but there is great concern about recent decisions (MSD, GSK and others) to scale back or close down their R&D in neuroscience. This is driven entirely by economics and flies in the face of healthcare need. Measures to share risk and streamline the bureaucracy associated with drug development must be urgently considered.

The development of research strategies to address neurodegenerative disease is seriously hampered by the lack of good animal models and biomarkers. This is in sharp contrast to the situation in the cancer field, which is an exemplar for translational research. It is recommended that lessons be drawn from cancer research.

Translation is key but sits at the interface between disciplines, creating delays in funding for those engaged in translational research, or worse, funding gaps into which even world class research can fall. It is recommended that relevant Research Councils develop strategies both to ensure continuity of funding and to promote high quality translational research.

The training of highly skilled personnel in interdisciplinary fields is challenging and may require the development of multicentre training programmes. This has led to shortages even in the areas in which the UK is leading, for example MR physics.

There are significant new opportunities in the field of computational neuroscience that should be actively encouraged.

Appendix 1: List of Attendees

Name	Organisation
Arlene Astell	University of St. Andrews
Mimoun Azzouz	University of Sheffield
Li Bai	University of Nottingham
Richard Bayford	Middlesex University
Martyn Boutelle	Imperial College London
Richard Bowtell	University of Nottingham
Kieran Breen	Parkinson's Disease Society
Doug Brown	MS Society
Alistair Burns	DeNDRoN University of Manchester
Michael Carroll	Newcastle University
Beining Chen	University of Sheffield
Joanna Collingwood	University of Warwick
Bernie Conway	University of Strathclyde
Damian Crowther	University of Cambridge
Belinda Cupid	MND Association
Patrick Degenaar	Imperial College London
Jim Deuchars	University of Leeds
Christopher Eccleston	University of Bath
Neil Evans	University of Warwick
Aldo Faisal	Imperial College London
Lee Glassbrook	BBSRC
Penny Gowland	University of Nottingham
Helen Griffiths	Aston University
William Griffiths	Swansea University
Ian Hamley	University of Reading
Ian Holliday	Aston University
Emmanuel Ifeachor	University of Plymouth

Name	Organisation
Christopher James	University of Southampton
David Jiles	Cardiff University
Peter Johnson	University of Bath
Bill Jones	University of Cambridge
Derek Jones	Cardiff University
Rosie Jones	North Bristol NHS Trust
Cleo Kontoravdi	Imperial College London
Kostas Kostarelos	University of London
Heba Lakany	University of Strathclyde
Zahid Latif	Technology Strategy Board
Joanna Lattimer	Medical Research Council
Dewi Lewis	General Electric Healthcare
Julian Matthews	University of Manchester
Richard McClatchey	University of the West of England
Gail Mountain	University of Sheffield
James Pickett	Alzheimer's Society
Zoë Robertson	Barnsley NHS
Emma Ross	University of Brighton
Mark van Rossum	University of Edinburgh
Simon Schultz	Imperial College London
Stephen Smith	University of Oxford
Sean Sweeney	University of York
Edward Tarte	University of Birmingham
Andrew Thomas	The Magstim Company Limited
Joy Todd	ESRC
Shouyan Wang	University of Southampton
Janet De Wilde	SINAPSE, University of Edinburgh
Haitao Ye	Aston University

Name	Organisation
Jane Zheng	University of Ulster

Appendix 2: EPSRC - Neurodegenerative Disease Day – Ramada Manchester Piccadilly Hotel, Manchester

Agenda for attendees- 11 February 2010

Time	Activity
09:30	**Registration and Coffee**
10:00	**Welcome, Background and Introduction to Panel** Aims and expected output - EPSRC
10:20	**Panel's Expectations for the Day** Panel Chair
10:30	**Format of the Day** EPSRC
10:40	**Sessions with Panel** - to look at questions (1) and (2) (1) What are the areas of Strength for this community in the UK? (2) What are the Gaps and/or opportunities for this community in the UK
12:00	**Lunch & Networking** An opportunity to mix with colleagues and panel members
13:15	**Feedback from Sessions**
13:45	**Sessions with Panel** - to discuss the issues (3) and (4) (3) Translation of basic research into products (4) Training/skills needs across the workforce in EPS healthcare
14:45	**Networking Coffee**
15:15	**Feedback from Sessions**
15:45	**Closing Remarks and Next Steps** *EPSRC*

Appendix 3: Breakout Groups

Green: Group 1: Professor Julie Williams and Dr Nicola Goldberg

- Richard Bayford
- Beining Chen
- Christopher Eccleston
- Ian Hamley
- Cleo Kontoravdi
- Heba Lakany
- Julian Matthews
- Janet De Wilde
- Denise Wilson
- Zahid Latif
- James Pickett

Yellow: Group 2: Professor Peter Morris and Dr Chloe Heywood

- Li Bai
- Michael Carroll
- Damian Crowther
- Patrick Degenaar
- Jim Deuchars
- Aldo Faisal
- Derek Jones
- Dewi Lewis
- Richard McClatchey
- Stephen Smith
- Shouyan Wang
- Gail Mountain

Blue: Group 3: Professor Peter Brown and Dr Amanda Chmura

- Arlene Astell
- Joanna Collingwood
- Penny Gowland
- David Jiles
- Rosie Jones
- Bill Jones
- Mark van Rossum
- Sean Sweeney

- Haitao Ye
- Lee Glassbrook

Red: Group 4: Professor Anya Hurlbert and Dr Tom Headen

- Richard Bowtell
- Belinda Cupid
- Helen Griffiths
- Christopher James
- Zoë Robertson
- Peter Johnson
- Kostas Kostarelos
- Andrew Thomas
- Simon Schultz
- Edward Tarte
- Huiru Zheng

Pink: Group 5: Dr Alastair Reith and Ms Linda Sayers

- Martyn Boutelle
- Emmanuel Ifeachor
- Mimoun Azzouz
- Emma Ross
- Ian Holliday
- William Griffiths
- Neil Evans
- Bernie Conway
- Doug Brown

Appendix 4: List of EPSRC grants relevant to the Neurodegenerative Disease Day

The grant data search was run for all live grants that had been coded to Health sector or socioeconomic theme as of April 2009.

Grant Ref	PI Name	Topic Value £	Grant Title
EP/E040918/1	Rodriguez y Baena, Dr FM	131,069.98 87,379.99	A Biomimetic Flexible Soft Tissue Probe for Computer Assisted Minimally Invasive Intervention
EP/D060982/1	Elwell, Professor CE	173,899.49 173,899.49	A multidisciplinary approach to non invasive optical measurements of cellular energetics in the human brain
EP/C010841/1	Wennekers, Dr T	465,494.10 465,494.10 930,988.21	A Novel Computing Architecture for Cognitive Systems based on the Laminar Microcircuitry of the Neocortex
EP/D07908X/1	Furber, Professor S B	159,460.12 95,676.07 63,784.05	A scalable chip multiprocessor for large-scale neural simulation
EP/D079594/1	Brown, Professor AD	98,481.32 59,088.79 39,392.53	A scalable chip multiprocessor for large-scale neural simulation
EP/D030099/1	Roberts, Professor S	162,416.10 18,046.23	AABAC: Adaptive Asynchronous Brain-Actuated Control
EP/D030552/1	Gan, Dr JQ	235,745.15 26,193.91	AABAC: Adaptive Asynchronous Brain-Actuated Control
EP/E038492/1	Schyns, Professor PG	70,435.79 105,653.69 176,089.48	Adaptive Sampling Algorithms for Cognitive Neuroscience Applications Using Bubbles

Grant Ref	PI Name	Topic Value £	Grant Title
EP/F028695/1	Matthews, Dr JC	104,497.72 104,497.72	Advanced Reconstruction Algorithms for PET Imaging in Oncology and Neuroscience
EP/E004156/1	Goulermas, Dr JY	94,267.38	An automated image analysis and measurement system for video-fluoroscopic evaluation of swallowing dysfunctions.
EP/E01609X/1	Turk, Dr A	309,788.04 61,957.61	An Edinburgh Speech Production Facility
EP/E016359/1	Scobbie, Professor JM	41,194.36 8,238.87	An Edinburgh Speech Production Facility
EP/G025770/1	Adlam, Mr TD	5,988.72	An N+N Workshop to Develop Proposals for Research into the Implementation of Assistive Technology for People with Dementia.
EP/D066654/1	Collingwood, Dr JF	113,455.71	Analysis and imaging of metal-ion accumulation in neurodegenerative disease
EP/D030978/1	Griffin, Dr LD	202,745.94	Basic Image Features
EP/E501311/1	MacKay, Professor RS	414,242.70	Capacity Building in Complexity Science at Warwick
EP/E002331/1	Ingram, Professor CD	1,009,442.50 1,009,442.50 1,009,442.50 1,009,442.50	CARMEN: Code analysis, repository, and modelling for e-Neuroscience
EP/C532058/1	Patel, Dr BA	34,881.49 69,762.97	Chemical characterisation of synaptogenesis

Grant Ref	PI Name	Topic Value £	Grant Title
EP/G039046/1	Barker, Dr JP	132,782.35	CHIME: Computational Hearing in Multisource Environments
EP/F011830/1	Rueckert, Professor D	460,039.56 115,009.89	Computational Morphometry of the Developing Cortex
EP/E064280/1	Alexander, Dr DC	199,331.12 199,331.12	Copy of A Monte-Carlo diffusion simulation framework for diffusion MRI
EP/D505593/1	Bell, Dr SL	15,936.98	Developing a clinical indicator of depth of anaesthesia based on auditory evoked potentials
EP/G004277/1	Bulte, Dr DP	457,845.72 196,219.59	Development of clinically viable, calibrated FMRI
EP/C500210/1	Hebden, Professor JC	169,331.28	Development of novel optical and photoacoustic instruments for clinical diagnosis and monitoring
EP/F023057/1	Bagshaw, Dr AP	182,475.76 182,475.76 91,237.88	Development of Single Trial EEG-fMRI: Investigations of Dynamic Brain Function at High Temporal and Spatial Resolution
EP/F025513/1	Foord, Professor J	68,527.33 68,527.33 102,790.99	Diamond devices for bioelectronic applications - invited resubmission
EP/F026110/1	Jackman, Professor RB	126,033.52 126,033.52 189,050.28	Diamond devices for bioelectronic applications - invited resubmission
EP/G007748/1	Alexander, Dr DC	985,822.96 422,495.56	Direct Measurements of Microstructure from MRI

Grant Ref	PI Name	Topic Value £	Grant Title
EP/E03165X/1	Procter, Professor R	92,162.07	Distributed Intelligent Learning Environment for Mammographic Screening
EP/E033490/1	Taylor, Dr PT	94,681.54	Distributed Intelligent Learning Environment for Mammographic Screening
EP/D066573/1	Anastassiou, Dr CA	75,809.54 126,349.23	Effects of a Spatial and Temporal Non-Uniform Extracellular Potential Distribution on the Activity of Single Neurones and Neuronal Populations
EP/F003684/1	Magill, Professor EH	15,398.86 15,398.86	Enabling health, independence and wellbeing for psychiatric patients through personalised ambient monitoring (PAM)
EP/F003714/1	Crowe, Dr J	16,310.61 16,310.61	Enabling health, independence and wellbeing for psychiatric patients through personalised ambient monitoring (PAM)
EP/F005091/1	James, Dr C	22,492.17 22,492.17	Enabling health, independence and wellbeing for psychiatric patients through personalised ambient monitoring (PAM)
EP/G062137/1	Battaglia, Dr G	651,959.42 869,279.22 651,959.42	Engineering Virus-like Nanoparticles for Targeting the Central Nervous System
EP/D051894/1	Stocks, Professor NG	241,697.90	Enhanced cochlear implant coding using stochastic beam-forming
EP/F039697/1	Davies, Professor ME	53,365.68	Extensions to compressed sensing theory with application to dynamic MRI

Grant Ref	PI Name	Topic Value £	Grant Title
EP/E039731/1	Gunning, Miss DE	65,727.76 43,818.51 109,546.27	High Spatial Resolution 3D Probes for Neurobiology Applications
EP/E03988X/1	Dowsey, Dr AW	24,991.94	High-throughput Differential Expression Proteomics
EP/F01144X/1	Atkinson, Dr D	86,847.55	HPC Software for Medical Imaging
EP/F011059/1	Roula, Dr MA	48,273.08	Implementation of Magnetic Induction Tomography image reconstruction algorithms on Clearspeed Advance co-processor.
EP/C536851/1	Clark, Dr CA	103,313.22 103,313.22	Improved brain connectivity measurements using in viro MR diffusion tractography
EP/F068514/1	Loram, Dr ID	86,062.13	Intermittent predictive control of man and machine
EP/F069022/1	Gollee, Dr H	33,404.89	Intermittent predictive control of man and machine
EP/F06974X/1	Lakie, Dr M	34,087.70	Intermittent predictive control of man and machine
EP/G500134/1	Tracey, Professor I	160,412.00 160,412.00 160,412.00 160,412.00	JEFI: Advanced MR Imaging of Brain Structure and Function in Health and Disease
GR/T23305/01	Lakany, Dr H	3,986.07 3,986.07	JEFI: Can artificial intelligence help in improving mobility in persons with motor disability?

Grant Ref	PI Name	Topic Value £	Grant Title
EP/F500688/1	Kourtzi, Professor Z	187,218.40 93,609.20 93,609.20 93,609.20	JEFI: Classification decisions in machines and human brains
EP/G501114/1	Deary, Professor IJ	79,520.70 106,027.60	JEFI: Cognitive Ageing and Cognitive Epidemiology
GR/T23770/01	Halliday, Dr D	5,501.10 5,667.80 5,501.10	JEFI: Development of a low cost clinical tool for quantifying the cardinal symptoms of Parkinson's Disease
EP/G500193/1	Alexander, Dr MR	17,600.50	JEFI: Directional guidance of neural outgrowth using topography and surface chemistry
EP/D509661/1	Liu ,Dr X	19,421.00	JEFI: Dynamics of the electric fields at the electrode/brain interface in deep brain stimulation of movement disorders
EP/D509432/1	Schoepfer, Professor R	18,415.00	JEFI: Exploring diamonds for electrical interfacing with neurons
EP/C546253/1	Morris, Professor PG	322,000.00 322,000.00	JEFI: Functional neuroimaging at ultra-high magnetic field
EP/D509947/1	Gunn-Moore, Dr FJ	20,862.00	JEFI: Photonic control of neuronal growth
EP/G500517/1	Harrison, Dr LM	13,222.65 5,666.85 18,889.50	JEFI: The Geometries of Neuronal Responses

Grant Ref	PI Name	Topic Value £	Grant Title
EP/D508150/1	Robinson, Professor C	102,444.80	LSI Doctoral Training Centre - University of Warwick
EP/F500386/1	Willshaw, Professor D	478,290.81 478,290.81 478,290.81 717,436.22 239,145.41 1,913,163.24	LSI Doctoral Training Centres - Neuroinformatics and computational neuroscience
EP/F500025/1	Robinson, Professor C	114,571.60 121,303.40	LSI Doctoral Training Centres: University of Warwick
EP/F50053X/1	Hannon, Professor MJ	604,594.32	LSI DTCs 2007: Physical sciences of imaging in the biomedical sciences (PSIBS)
EP/G007144/1	Plumbley, Professor M	309,194.04	Machine Listening using Sparse Representations
EP/G025452/1	Clark, Dr CA	315,835.80 35,092.87	Markov Chain Monte Carlo Random Effects Modelling in Diffusion MRI: a New Window on Microstructure and White Matter Architecture
EP/F011857/1	Coombes, Professor S	52,619.09 13,154.77 65,773.87	Mathematical Neuroscience Network
EP/D068436/1	Terry, Dr JR	44,490.39 177,961.54 177,961.54	Mean field modelling of human EEG: Application to Epilepsy Seizure Prediction

Grant Ref	PI Name	Topic Value £	Grant Title
EP/E039278/1	Miller, Dr PW	138,646.18	Microfluidic Devices Applied to the Synthesis of [11C]methyl Labelled Molecules of Biological Interest for Positron Emission Tomography (PET)
EP/D055466/1	Erwin, Dr HR	73,054.38 73,054.38	Midbrain Computational and Robotic Auditory Model for focused hearing (MiCRAM)
EP/D060648/1	Rees, Dr A	75,355.60 75,355.60	Midbrain Computational and Robotic Auditory Model for focused hearing (MiCRAM)
EP/E004105/1	Walden, Professor AT	119,319.59 119,319.59	Multivariate time series graphical modelling for analysis of brain connectivity in schizophrenia sufferers
EP/G061505/1	Lawrence, Professor MJ	341,211.52	Nanoparticles for the Targeted Delivery of Therapeutic Agents to the Brain for the Treatment of Dementias.
EP/G061521/1	Hart, Dr SL	1,391,286.77	Nanoparticles for the Targeted Delivery of Therapeutic Agents to the Brain for the Treatment of Dementias.
EP/G061831/1	Gill, Professor S	21,195.32	Nanoparticles for the Targeted Delivery of Therapeutic Agents to the Brain for the Treatment of Dementias.
EP/G061866/1	Love, Professor S	286,356.10	Nanoparticles for the Targeted Delivery of Therapeutic Agents to the Brain for the Treatment of Dementias.
EP/G008787/1	Panerai, Professor R	54,844.55 54,844.55	New methods for assessing the control of blood flow in the brain

Grant Ref	PI Name	Topic Value £	Grant Title
EP/G010420/1	Simpson, Dr DM	77,568.91 77,568.91	New methods for assessing the control of blood flow in the brain
EP/F05727X/1	Smith, Professor SM	58,989.14 176,967.42 58,989.14 58,989.14 176,967.42	New Tools for Understanding White Matter Disease using Diffusion MRI
GR/T19070/01	Dunnett, Professor S	12,697.80 12,697.80	Novel Protocols For Magnetic Resonance Imaging Of Stem Cell Transplants In The Brain
EP/D502330/1	Gibson, Dr AP	326,084.12	Optical Tomography of the Neonatal Brain
EP/E034950/1	Arridge, Professor SR	314,731.41	Parameter and Structure Indentification in Optical Tomography
EP/G005508/1	Murray, Professor AF	10,265.20 20,530.40	Patterning Biological Cells Using Microfabrication Technology
EP/D042917/1	White, Professor NM	83,373.79	PLATFORM: New directions for intelligent sensors
EP/G00420X/1	Anderson, Professor HL	47,854.24	Porphyrin Dimers for Photodynamic Therapy
EP/G050821/1	Turner, Mr R E	119,818.51 119,818.51	Probabilistic Auditory Scene Analysis
EP/C539788/1	Woolrich, Dr MW	241,085.81	Probabilistic Biophysical Modelling for Multimodal Functional MRI of the Brain
EP/F058586/1	Adams, Dr RJ	122,641.48	Quantifying cell behaviour in morphogenesis

Grant Ref	PI Name	Topic Value £	Grant Title
GR/S54685/01	Gibson, Dr AP	41,861.15	Quantitative medical optical tomography using a priori anatomical information
EP/D051592/1	Green, Dr S	119,101.84	Radiobiology studies for the evaluation of epithermal neutron beams used for Boron Neutron Capture Therapy
EP/E062954/1	Harper, Dr S	84,453.55	SASWAT: Structured Accessibility Stream for Web 2.0 Access Technologies
EP/D001935/1	Smith, Professor SM	81,643.88 326,575.51	Spatiotemporal Analysis of Functional MRI Data
EP/E062962/1	Baker, Professor SN	21,169.89 42,339.79	Spike Train Analysis Network
EP/F005512/1	Russell, Dr NA	266,375.46 66,593.87	Surface plasmon resonance imaging of neural network activity
EP/D001218/1	Zheng, Dr Y	66,069.21 132,138.41 66,069.21	System Identification and Signal Processing for Neuro Imaging Data Analysis
EP/G061483/1	Uchegbu, Professor I	758,193.80	Technologies for the Treatment of Brain Diseases
EP/G061564/1	Moger, Dr J	241,110.33	Technologies for the Treatment of Brain Diseases
EP/G061815/1	Begley, Dr D J	332,413.56	Technologies for the Treatment of Brain Diseases
EP/C011953/1	Cohen, Dr N	129,823.22 241,917.54	The C. elegans locomotion nervous system: an integrated multi-disciplinary approach

Grant Ref	PI Name	Topic Value £	Grant Title
EP/G007543/1	Seth, Dr AK	557,204.30 557,204.30	Towards a next-generation computational neuroscience
EP/F048114/1	Hamley, I	305,695.71	Self Assembly of multiply responsive peptide copolymers
EP/G030952/1	Hamley, I	15,280.68	Amyloid peptide conjugates: visit to Argentina to develop collaboration

Appendix 5: Results from Bristol on Line Survey

Neurodegenerative Diseases Survey Results

Survey Overview

Section 1: Personal Details

1. Name

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

2. Affiliation

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

3. Email address

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

Section 2: Background Information

4. Please tick boxes which relate to your research area.

Modelling and Simulation:		n/a	12
Brain Sciences:		n/a	16
Neurodegenerative Diseases:		n/a	22
Cognitive Science:		n/a	6
Vision, Hearing and Other Senses:		n/a	5
Artificial Intelligence:		n/a	1
Drug Formulation and Delivery:		n/a	7
Neural Computing:		n/a	1
Materials Research:		n/a	5
Signal Processing:		n/a	12
Imaging:		n/a	15
Other (please specify):		n/a	10

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

5. Have you been awarded any EPSRC grants in the last 5 years as a Principal Investigator or Co-investigator?

Yes:		54.1%	20
No:		45.9%	17

5.a. If yes, please give details e.g. grant reference number

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

6. Do you hold any current research grants that have been awarded by another funding agency?

Yes:		73.0%	27
No:		27.0%	10

6.a. Which other agency have you received funding from?

MRC:		n/a	5
BBSRC:		n/a	7
Technology Strategy Board:		n/a	2
Other Government Department:		n/a	5
Industry:		n/a	13
Charity:		n/a	10
EU:		n/a	7
Other (please specify):		n/a	7

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

6.b. Please provide details of the research grants you currently hold that are related to this area.

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

7. Have you encountered any barriers to funding the next stages of your research e.g. into products?

Yes:		48.6%	18
No:		51.4%	19

7.a. If yes, please describe these barriers.

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

8. Do you engage with users in developing your research e.g. clinicians, patients and industry?

Yes:		89.2%	33
No:		10.8%	4

8.a. Please indicate which users you engage with

Clinicians:		n/a	31
Patients:		n/a	12
Large companies:		n/a	13

SMEs:		n/a	14
Other (please specify):		n/a	10

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

8.b. How often do you engage with users and what form does this take?

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

9. How much consideration do you give to future clinical adoption when developing ideas for your research?

High:		62.2%	23
Medium:		35.1%	13
Low:		2.7%	1

9.a. If appropriate, please explain your answer.

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

Section 3: Strengths in EPSRC's Healthcare Portfolio

10. What are the UK's strengths in the area of Neurodegenerative Diseases research? Please use evidence to back up your statements (e.g. citations, bibliometrics, RAE returns, conference invitations)

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

11. For your areas of expertise within the field of Neurodegenerative Diseases, how does UK research compare internationally?			
11.a. Modelling and Simulation			
UK is World leader:		12.0%	3
UK is internationally excellent:		20.0%	5
UK is recognised internationally:		24.0%	6
UK is recognised nationally:		4.0%	1
UK is below national recognition:		0.0%	0
Not area of expertise:		40.0%	10
11.a.i. Modelling and Simulation -- Please provide comments and evidence to explain your response.			
There are too many responses to display on this page and so all the responses to this question are available on a separate page.			
11.b. Brain Sciences			
UK is World leader:		25.0%	7
UK is internationally excellent:		46.4%	13
UK is recognised internationally:		7.1%	2
UK is recognised nationally:		0.0%	0
UK is below national recognition:		0.0%	0
Not area of expertise:		21.4%	6
11.b.i. Brain Sciences -- Please provide comments and evidence to explain your response.			
There are too many responses to display on this page and so all the responses to this question are available on a separate page.			
11.c. Neurodegenerative Diseases			
UK is World leader:		16.7%	5
UK is internationally excellent:		43.3%	13
UK is recognised internationally:		30.0%	9
UK is recognised nationally:		3.3%	1
UK is below national recognition:		0.0%	0
Not area of expertise:		6.7%	2
11.c.i. Neurodegenerative Diseases -- Please provide comments and evidence to explain your response.			
There are too many responses to display on this page and so all the responses to this question are			

available on a separate page.

11.d. Cognitive Science

UK is World leader:	8.3%	2
UK is internationally excellent:	45.8%	11
UK is recognised internationally:	12.5%	3
UK is recognised nationally:	4.2%	1
UK is below national recognition:	0.0%	0
Not area of expertise:	29.2%	7

11.d.i. Cognitive Science -- Please provide comments and evidence to explain your response.

ditto

11.e. Vision, Hearing and Other Senses

UK is World leader:	4.0%	1
UK is internationally excellent:	40.0%	10
UK is recognised internationally:	12.0%	3
UK is recognised nationally:	8.0%	2
UK is below national recognition:	0.0%	0
Not area of expertise:	36.0%	9

11.e.i. Vision, Hearing and Other Senses -- Please provide comments and evidence to explain your response.

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

11.f. Artificial Intelligence

UK is World leader:	0.0%	0
UK is internationally excellent:	20.0%	4
UK is recognised internationally:	30.0%	6
UK is recognised nationally:	0.0%	0
UK is below national recognition:	0.0%	0
Not area of expertise:	50.0%	10

11.f.i. Artificial Intelligence -- Please provide comments and evidence to explain your response.

ditto

11.g. Drug Formulation and Delivery

UK is World leader:		9.5%	2
UK is internationally excellent:		28.6%	6
UK is recognised internationally:		23.8%	5
UK is recognised nationally:		4.8%	1
UK is below national recognition:		0.0%	0
Not area of expertise:		33.3%	7
11.g.i. Drug Formulation and Delivery -- Please provide comments and evidence to explain your response.			
ditto			
11.h. Neural Computing			
UK is World leader:		0.0%	0
UK is internationally excellent:		26.1%	6
UK is recognised internationally:		13.0%	3
UK is recognised nationally:		13.0%	3
UK is below national recognition:		4.3%	1
Not area of expertise:		43.5%	10
11.h.i. Neural Computing -- Please provide comments and evidence to explain your response.			
ditto			
11.i. Materials Research			
UK is World leader:		4.3%	1
UK is internationally excellent:		26.1%	6
UK is recognised internationally:		17.4%	4
UK is recognised nationally:		8.7%	2
UK is below national recognition:		0.0%	0
Not area of expertise:		43.5%	10

11.i.i. Materials Research -- Please provide comments and evidence to explain your response.			
There are too many responses to display on this page and so all the responses to this question are available on a separate page.			
11.j. Signal Processing			
UK is World leader:		4.2%	1
UK is internationally excellent:		41.7%	10
UK is recognised internationally:		4.2%	1
UK is recognised nationally:		8.3%	2
UK is below national recognition:		0.0%	0
Not area of expertise:		41.7%	10
11.j.i. Signal Processing -- Please provide comments and evidence to explain your response.			
There are too many responses to display on this page and so all the responses to this question are available on a separate page.			
11.k. Imaging			
UK is World leader:		12.5%	3
UK is internationally excellent:		54.2%	13
UK is recognised internationally:		4.2%	1
UK is recognised nationally:		0.0%	0
UK is below national recognition:		0.0%	0
Not area of expertise:		29.2%	7
11.k.i. Imaging -- Please provide comments and evidence to explain your response.			
There are too many responses to display on this page and so all the responses to this question are available on a separate page.			
11.l. Other (please specify in comments)			
UK is World leader:		25.0%	2
UK is internationally excellent:		25.0%	2
UK is recognised internationally:		12.5%	1
UK is recognised nationally:		0.0%	0
UK is below national recognition:		0.0%	0
Not area of expertise:		37.5%	3
11.l.i. Other (please specify in comments) -- Please provide comments and evidence to explain your			

response.

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

11.m. Other (please specify in comments)

UK is World leader:		0.0%	0
UK is internationally excellent:		33.3%	2
UK is recognised internationally:		0.0%	0
UK is recognised nationally:		0.0%	0
UK is below national recognition:		0.0%	0
Not area of expertise:		66.7%	4

11.m.i. Other (please specify in comments) -- Please provide comments and evidence to explain your response.

Cellular and molecular imaging

Understanding the role of psychological and sociological treatments

11.n. Other (please specify in comments)

UK is World leader:		0.0%	0
UK is internationally excellent:		0.0%	0
UK is recognised internationally:		0.0%	0
UK is recognised nationally:		0.0%	0
UK is below national recognition:		0.0%	0
Not area of expertise:		100.0%	4

11.n.i. Other (please specify in comments) -- Please provide comments and evidence to explain your response.

11.o. Other (please specify in comments)

UK is World leader:		0.0%	0
UK is internationally excellent:		0.0%	0
UK is recognised internationally:		0.0%	0
UK is recognised nationally:		0.0%	0
UK is below national recognition:		0.0%	0
Not area of expertise:		100.0%	3

11.o.i. Other (please specify in comments) -- Please provide comments and evidence to explain your response.

Section 4: Gaps in EPSRC's Healthcare Portfolio

12. Please describe any gaps that you consider exist within UK research in Neurodegenerative Diseases, giving evidence for your statements.

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

12.a. How do you think these gaps may be addressed?

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

Section 5: Looking ahead to 2019

13. What do you consider is needed in the future to ensure that there is a sufficient balance of skills across all levels (from early training through to highly skilled specialists) within the area of Neurodegenerative Diseases?

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

14. Do you have any success stories from EPSRC funded research related to this area? For example, patents, spin outs, impact or good news case studies. Please provide details below.

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

14.a. Do you have any success stories from research in this area from other funding sources? Please provide details below.

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

15. We welcome any more general comments, not already covered in this survey, that you would like to make about EPSRC funding in the area of Neurodegenerative Diseases (200 words maximum)

There are too many responses to display on this page and so all the responses to this question are available on a separate page.

Appendix 6: Bibliometric data on Journals picked by Neurodegenerative Disease Panel

Bibliometric Data based upon Journals suggested by the Panel Members of the Neurodegenerative diseases Portfolio Day

This report has been put together with citation data from Thomson Reuters' Web of Science (WoS). From this I've extracted citation counts for articles and review articles from a set of journals suggested by the panel, with the aim of assessing the performance of the UK in this field. This is complemented by additional analyses in the annex, including citation data for the closest fitting Thomson Scientific fields.

The journal set we have used represents the most popular journals for some of the UK's top scientists. As such, we should bear in mind that it is possible that the UK might be shown in a more positive light than she otherwise would be. The UK is compared to world average values as well as the USA, Germany, France, China and the EU-27. The EU-27 includes the UK along with all the EU member states.

To indicate the quality of research we use the citation impact (defined as the number of cites per paper) of a set. To smooth out trends I have put the data over five year rolling windows, starting with 2000-2004, up to 2005-2009. WoS was last updated on 04 February 2010. Data using the total cites for a paper uses all citations (ie including those in the partial year 2010), data using the 5-year citations uses only those cites in the first five full years after publication, and does not include 2010 citations.

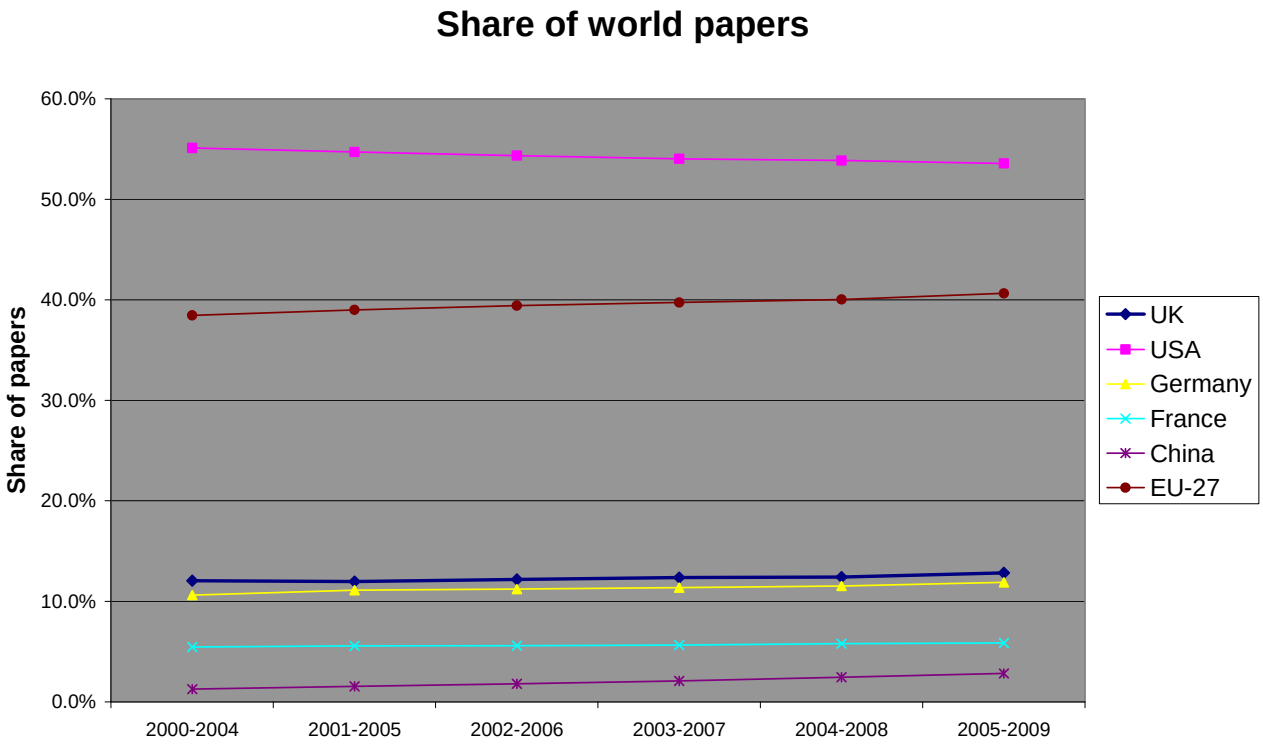
Summary

Overall we see that the UK is increasing output at a consistent level, matching the global rise, which is largely due to China's growth, in terms of publications, of 183% from 2000-2009. Out of the countries analysed, the UK is second in terms of publication volumes to the USA. Citations impact figures indicate our research is high quality, being consistently above average. In the last two five year windows, France has risen up to second place, narrowly ahead of the UK.

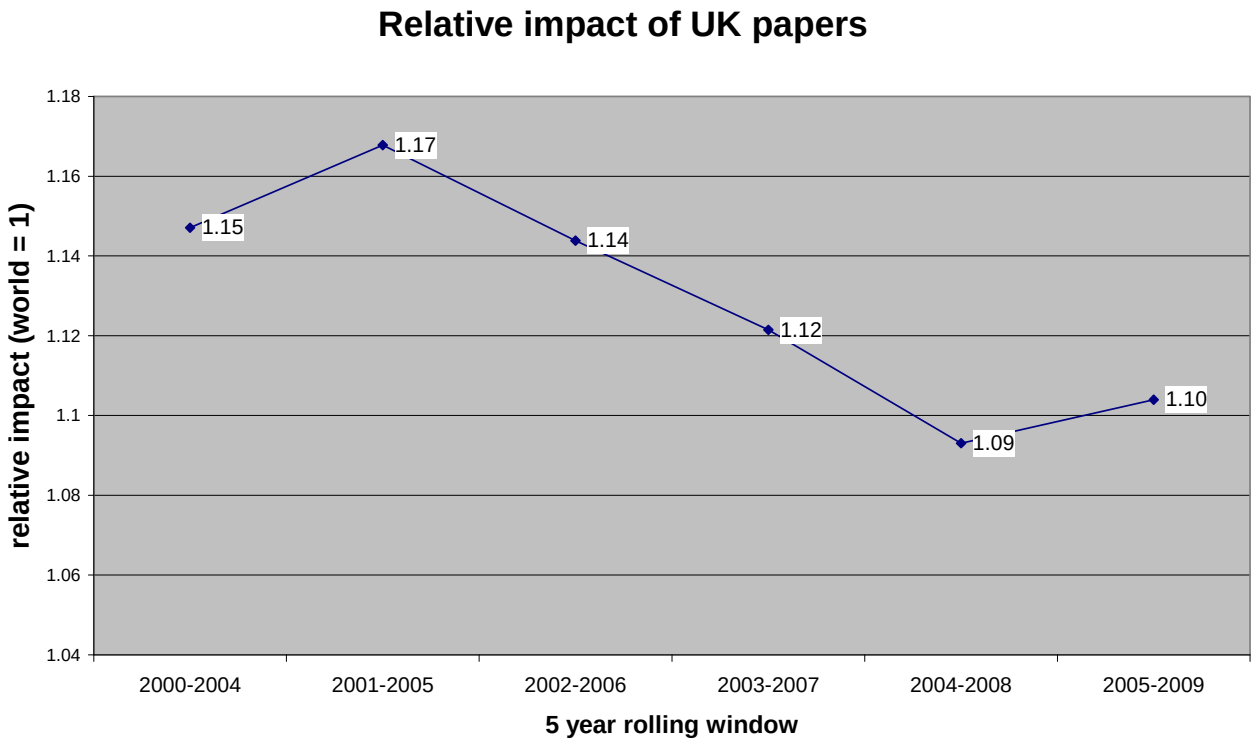
Using the Thomson designated fields relating to Neurodegenerative health, the UK comes out very well. The UK is in first place for both 'Clinical Neurology' and 'Neuroimaging', and a close second to the USA in Neurosciences.

Analysis

Below is a chart showing the UK share of world papers. This shows that although the UK produces a small proportion of papers (about 12-13% of world totals), it is second only to the USA, where over half of world papers have authors. It is also pleasing to note that the UK's share of papers is not falling, as it is in many other disciplines (rather it makes a modest rise from 12.1% in 2000-2004 to 12.8% in 2005-2009). In real terms the UK's output rises by 55%, compared to a world rise of 43% over the same time (comparing publication volumes for 2000-2009).

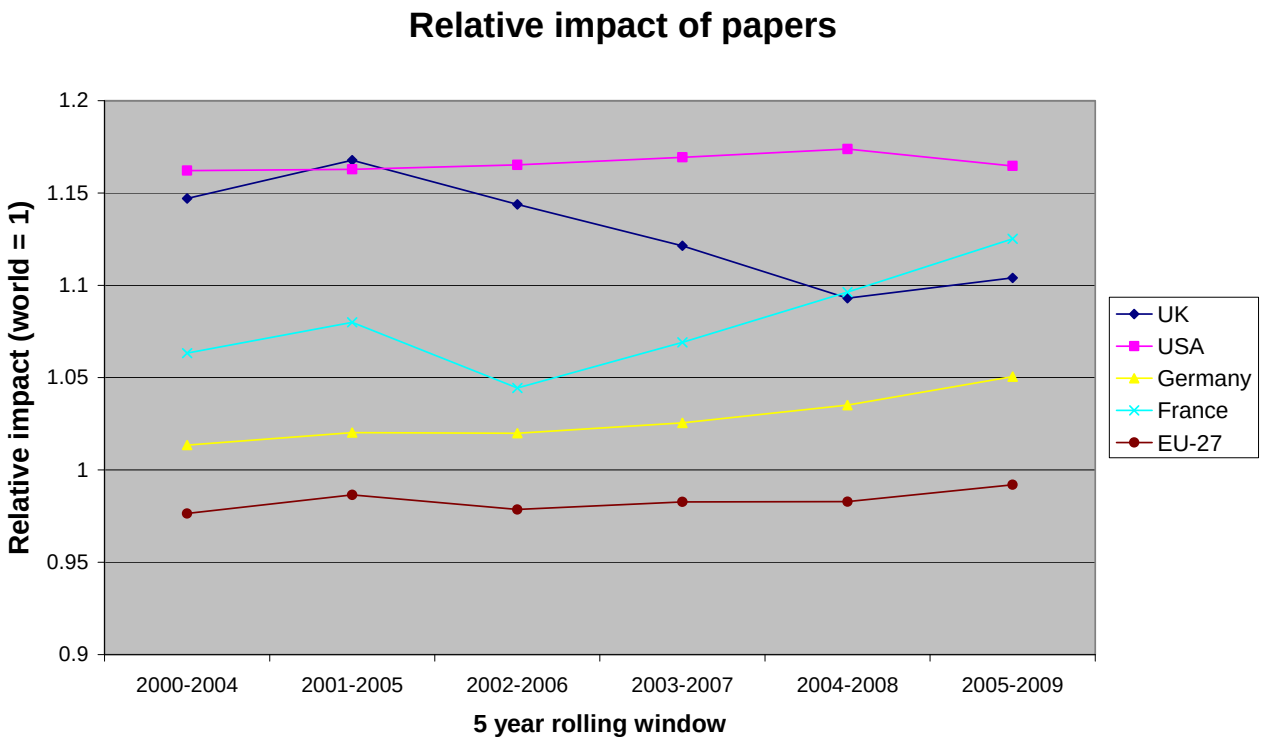


Relative Impact



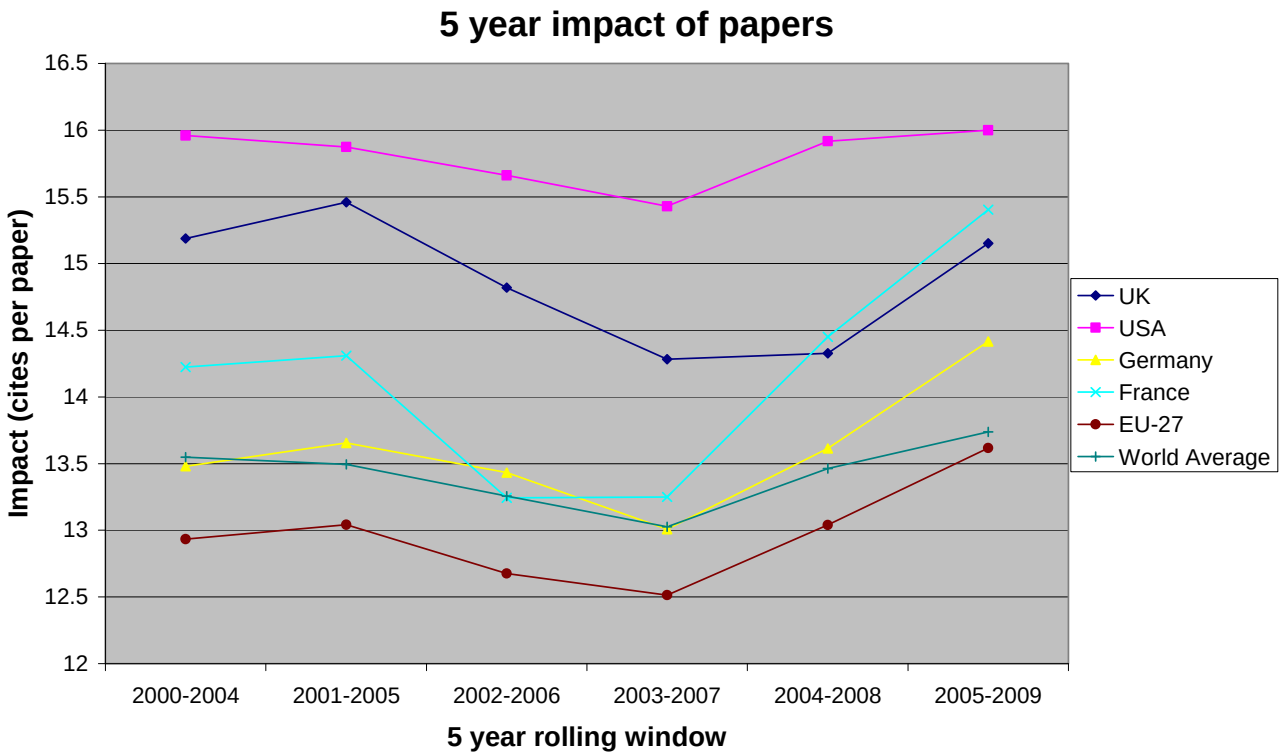
This chart shows the UK's performance, relative to world average, in terms of citations impact (using all cites a paper receives). As we can see, the UK is above average, but has a falling trend. From the non-relative impact chart (see later on) it appears that this is because the rest of the world is getting better, rather than us getting worse. Below is the relative impact of the UK, the competitor countries and the EU. China is excluded from this chart, as the low impact scores

make the rest of the graph harder to read. A copy including China can be found in Annex B. The UK performs well overall, spending most time second to the USA, but rising to first in 2001-2005. In 2004-2008 and 2005-2009 we are overtaken by France, pushing us back into third place.



Citation Impact

To use non-relative values, below is a chart showing the five year citations for papers. This shows, for papers in a five year window, the citations received for them in those five years. This shows that the UK's impact is pretty steady, hovering about 15. In contrast the worldwide citations levels seem to rise above the odds, again pushing us back to third place in the last five year windows. Again a chart with the figures for China included is in Annex B.


5 year impact of papers
Impact (cites per paper)
16.5
16
15.5
15
14.5
14
13.5
13
12.5
12
2000-2004
2001-2005
2002-2006
2003-2007
2004-2008
2005-2009
5 year rolling window
UK
USA
Germany
France
EU-27
World Average