Unit of Assessment 4 – Psychology, Psychiatry and Neuroscience

Institution	Evidence
University of Dundee	We have undertaken analyses based on the information available to us but this has not revealed any meaningful trends to inform the review.
Medical Research Scotland	Medical Research Scotland appreciates the opportunity to participate but are not able to provide the requested data.
University of Aberdeen	Research within this unit of assessment covers a very wide range of approaches, from clinical settings to research that adopts social sciences approaches. This is recognised by awarding the medium subject weighting. The broad mix of activities has not changed over the last three research assessment exercises. The recent pilot exercise undertaken by the REF2021 team looked at all outputs submitted to REF2014 and tried to establish the percentage of outputs that were based on research involving high cost and specialist research facilities. For Aberdeen, this was around one third of all outputs submitted to this unit of assessment, with a further third falling into a high cost category (high labour intensity or other associated cost of collecting data). This points towards an increase rather than a reduction of the subject weighting. The presence of a medical school on the Aberdeen campus enables access to high cost facilities for psychology research. It is important to note that, although the unit of assessment covers a wide range of research activity, it is not possible to separate 'high cost' from 'low cost' activity, as they often complement each other within projects or research programmes. It is vital for the integrity of the discipline that this is maintained. As for UoA 2, we would argue that the possibilities offered by the use of large datasets has increased the cost of

	research in this area. This includes access and use to high power computing facilities, and the associated overhead costs for staffing and maintenance, and for safe storage and curation of data, much of which is met from overheads and REG. This trend is likely to continue and accelerate, and indicates maintaining or increasing the subject weighting for this unit of assessment.
University of Stirling	**1. Changes in research practice in areas covered by Unit of Assessment 4.** There have been significant changes in the way that research in this UOA has been conducted. Where previously there may have been a focus on a social science aspect of psychology, changes in the needs of society and funders and in available technology have resulted in a shift from a broadly qualitative research base to a more quantitative research base. These changes have driven the discipline to be more "scientific" in its approach and this has been supported by advances in more readily available technologies that have enabled or eased studies involving, for example, the monitoring of brain processes, thermal imaging, eye tracking and genetic studies. The change and availability of several technologies, in particular a proliferation of wireless internet access and body wearable devices has helped facilitate a move from the class room to the lab and in turn to real world studies. These changes in the availability and the diversity of technology mean that researchers require more technological skills and training than 20 years ago. Study sizes have also changed over this time with many studies seeking larger sample sizes than in 1997/98.

	2. Changes in the balance of research activity between constituent discipline areas covered by Unit of Assessment 4. Changes to the balance of activity at Stirling has changed over the 3 time periods since 1997/8 1997/9 100% Psychology, 0% Neuroscience 2007/8 95% Psychology, 5% Neuroscience 2017/8 90% Psychology, 10% Neuroscience This balance has again been driven by technology that has enabled observation of brain and other physical processes. **3. Changes in levels of support required by academics active in research in the disciplines covered by Unit of Assessment 4, specifically in terms of** • **Research Assistants or equivalents;** • **Specialist support staff such as technicians;** • **Access to specialist research equipment, infrastructure and facilities.** As the technological needs of the discipline have changed so too has the support required to conduct this research. Both research assistants and technicians require an ever-growing repertoire of technological skills and training to familiarise them with an ever-changing collection of technologies available to them. The technology itself requires support in the form of capital investment for both hardware and software. Modern software and hardware is not a fixed entity at point of purchase and on-going costs for licensing and support from vendors is required to enable new, enhanced and well serviced functionality within devices and systems.

	As research moves out of the laboratory and into the real world, often involving the use of hardware, there is increased resource being devoted to on-going upgrades and maintenance of equipment over the course of a project as wear and tear experienced in the real world is much more prominent than experienced in the laboratory environment. Some specialist laboratory equipment and expertise is not always available to the institution due to the outlay required therefore rental of laboratory time and equipment from other institutions and bought in support for the technological expertise is required. **4. Changes in the volume (i.e. number and/or size) of research grants won per researcher active in the disciplines covered by Unit of Assessment 4.** Year Researcher (count) No Awards Sum of awards (£000's) Avg Award Value (£000's) Avg Award per researcher (£000's) 1997-98 5 7 381 54 50 2007-08 12 15 1887 126 157 2017-18 10 13 841 65 84 **5. Any other sources of evidence that might illustrate any changes in the absolute costs of research activity in the disciplines covered by Unit of Assessment 4 since 1997-98.** Institutional TRAC returns show that the recovery of full economic costs at the institution is in steady decline. In the year 2011/2 TRAC recovery of full economic cost on research was 71.9% in the latest TRAC return of 2017/8 this is sitting at 60.7%.
The	Heads of Psychology Departments are typically responsible for all aspects of teaching and research (including REF)

Association of Heads of Psychology	and are well informed about the changing nature of the discipline, having day-to-day responsibility for leading and managing research (including accountability for budgets). However, access to the kinds of quantitative data requested in this consultation is not uniformly and readily accessible by Heads. Concern was expressed that this requirement was an unrealistic expectation for many of the relevant stakeholders. **1. Changes in research practice in areas covered by Unit of Assessment 4.** There have been significant changes in research focus within this UoA. In broad terms, the shift has been to move away from other cost areas of Psychology, towards relatively high cost Cognitive Neuroscience areas. There has been a dramatic increase in the use of measures of brain function (including MEG, EEG, NIRS, fMRI) and related methods of brain stimulation (altering brain function through the use of electrical, magnetic, radiowave, or focally targeted pharmacologic stimulation). This change is accelerating, with the rapid development of wireless wearable technology and the widespread adoption of biological/physiological measures (from eye-tracking to thermal imaging and genetic screening). Critically, the introduction of this broad array of new techniques has delivered a range of new psychological insights, and these techniques have been applied successfully across a range of contemporary Psychology research areas. Over the last twenty years, and particularly since REF2014, there has also been a significant method-driven shift within the discipline towards enhanced scientific rigour. This requires far more methodologically robust studies, more focus on replication, enhanced statistical sophistication, greater use of specialist modelling techniques, wider use of cohort and longitudinal approaches (cf. the Lothian Birth Cohort studies). Such developments have significantly increased cost, ranging from higher participant payment costs associated with the time and inconvenience involved in imaging/stimulation paradigms, to increased staff costs associated with the coordination and implementation of larger, longer, studies.

There has also been a dramatic shift towards working on real world research issues, reflecting emphasis on inter-disciplinary collaboration and research with impact. Together, these changes have driven researchers to develop wider technological expertise, to work in larger teams, collecting more data, and engage in more training, all of which has cost implications.

As a discipline, Psychology has been at the forefront of concern about replication, and has led significant changes in best practice that go beyond traditional scientific standards (ranging from adopting open science framework practices to encouraging pre-registered reporting, from demanding substantial increases in power to moving away from traditional frequentist statistics) – all of which places substantial new burden on the cost base of Psychology.

2. Changes in the balance of research activity between constituent discipline areas covered by Unit of Assessment 4.

There has been a significant increase in Cognitive Neuroscience within Psychology, reflecting a wider shift from a broadly qualitative research base to a more quantitative research base. This change reflects greater focus on the areas that provide the highest quality outputs for REF UoA4. In the absence of publically available data, our best estimates are that Human Cognitive Neuroscience has gone from 5% of the discipline in 97/98, to 20% in 07/08, and to 35% in 17/18 – growth that shows no sign of slowing.

Areas that have seen particular decline include Social Psychology, Developmental Psychology and Qualitative Methods. This does not reflect any actual or perceived difference in research quality or excellence in these areas, but that the resources (appointment of new staff in particular) have followed what was perceived to be valued by RAE/REF panels. It is also important to recognise that departments are highly heterogeneous – there are individual departments that have retained a significant focus on Social and Qualitative methods; others are almost entirely Neuroscience focused.

The change in focus within the discipline is evident in the nature of Psychology submissions to REF. Notably, in

	REF2014 the final submission to UoA4 included only two-thirds of the staff who were initially identified as eligible for submission. REF2014 outcomes show that research within UoA4 has become heavily Neuroscience-focused, with other sub-areas (ranging from Social and Education Psychology to Sports and Exercise Psychology and Occupational and Organisational Psychology) moving out of the discipline and submitted in other UoAs. There is considerable concern within the discipline that these changes are driving fragmentation of Psychology, and that REF2021 will see this extended (researchers in areas such as Health and Development are increasingly concerned about being squeezed out). In this context, it particularly important to note that all the bodies that represent Psychology nationally (the AHPD and the British Psychological Society, together with the Experimental Psychology Society) recently campaigned successfully against recent REF2021 proposals to introduce differentiated costings for Psychology research submitted to the REF as being 'high-cost' or 'other-cost'. This split-costing approach is not supported by the discipline because it is clear that the unintended consequence would be to drive further change to the nature of the discipline based on institutional drivers around cost (rather than based on the judgements of individual scientists choosing to work in one area of another). **3. Changes in levels of support required by academics active in research in the disciplines covered by Unit of Assessment 4, specifically in terms of** • **Research Assistants or equivalents;** • **Specialist support staff such as technicians;** • **Access to specialist research equipment, infrastructure and facilities.** Changes in levels of support required by academics have been significant. The increased emphasis on technology and biological/physiological measures (noted above) carries a clear need for enhanced infrastructure, equipment and technical support.

Wider changes in University budgets and governance mean that there has been significant pressure on budgets (especially related to teaching and admin support) – and across all institutions this has driven increases in the centralisation of facilities and downward pressure on the cost base of departments – in short the requirement for greater support is present, but often the resources to provide this support are not.

There has been significant increase in capital investment – one-off funds to support the development of facilities, purchase hardware and software, etc. A variety of different models to support research have been introduced across the sector, with consortiums between institutions becoming increasingly common (e.g., to share the cost of an fMRI centre), as is the outsourcing of facilities (e.g., purchasing access to facilities at a rival institution that cannot be provided locally).

Many of these approaches are seen as sensible ways of achieving cost-savings – but are also seen as viable only for a small number of specialist activities. More broadly, neither administrative nor technical support staffing levels have kept pace with the requirements of the discipline (reflecting wider cost pressures, not lack of need).

4. Changes in the volume (ie number and/or size) of research grants won per researcher active in the disciplines covered by Unit of Assessment 4.

Changes in the volume of research grants does not provide direct useful insight into the cost base of the discipline – because the availability of funding is driven by so many factors (ranging from national economic health to government prioritisation of specific issues).

Within the context of wider pressure on university budgets, the pressure on individuals and departments to deliver grant income increases continuously. Over the last ten-fifteen years there has been a significant diversification in the nature of the research grants applied for and won. Notable changes include greater focus on longer and larger interdisciplinary team-based funding (including particular reliance on large EU grants); increasing reliance on small grants from charities and specialist funders; and increased leverage of university funds via collaborative funding (e.g.,

	from industry and third sector bodies). Overall, therefore, it is clear that within psychology there has been marked fragmentation in funding, with a small volume of individual researchers attracting very large awards, alongside the majority of researchers who rely on a diverse range of smaller awards from an ever broader range of sources. In this context the Funding Council allocations for research is considered vitally important in permitting a plurality of research approaches (methods, topics, aims, epistemologies) to survive - it is also seen as providing an essential basic level of research funding that creates a platform from which a small cadre of elite highly funded researchers can develop and emerge. **5. Any other sources of evidence that might illustrate any changes in the absolute costs of research activity in the disciplines covered by Unit of Assessment 4 since 1997-98.** There has been a significant increase in the administrative burden associated with research. For example, institutions have been required to place increased emphasis on auditable administrative processes, for example associated with assessing and reporting on Health and Safety, for oversight of research Ethics, and for the monitoring of career development and progression. Whilst these activities are all valuable and important, they are also typically added to the requirements of a department without additional income or resources. The gradual growth in administrative and legislative burden has had significant impact on the funds available for research. Examples of the impact that this has had include: the withdrawal of travel funding for academic staff to attend conferences and engage in research meetings, to staff using their own salaries to purchase basic equipment to keep laboratories running. A common view is that the relatively low funding weight associated with UoA4 provides Universities with a rationale for why Psychology does not require the levels of non-staff budget that would be considered necessary in traditional science and medicine departments.

	Finally, whilst some of the issues raised are likely to apply across many more disciplines than just those covered by UoA4 (e.g., centralisation of support; general cost pressure within universities), it is clearly the case that the changing nature of Psychology as a discipline is unique – not only are there specific issues within Psychology that do not apply everywhere (e.g., the move towards Cognitive Neuroscience; the impact of the replication crisis), but Psychology is unusual in being a 'hub' discipline within the sciences. The very nature of Psychology (understanding mind and behaviour) means that the discipline can play a role in almost any other discipline – this has resulted in Psychologists migrating into many other departments (indeed the BPS has calculated that Psychological research was submitted to at least 15 UoAs in REF2014). The issue of the fragmentation of Psychology is a real concern within the community, and we hope that the Funding Council understand the importance not just of the funding, but of the signal that re-banding Psychology would send to Universities about the value of the discipline.
University of Edinburgh	**1. Changes in research practice in areas covered by Unit of Assessment 4.** Since 1997-98, the disciplines covered within the areas now represented within UoA 4 have undergone significant changes, as follows. **Neuroscience** Since 2008 there have been massive advances in brain research, where previously brain inaccessibility and absence of non-invasive approaches meant there was little that could be done to investigate brain disease. This requires the adoption of advanced and constantly evolving technologies, international and national coordination of effort and dynamic scientific programmes – at high cost. For basic research in Edinburgh, neuroscience teams now routinely perform live imaging of the brain using

	fluorescence microscopy, use virtual reality environments testing mice with implanted electrodes and microscopy lenses, lesion models for studies of regeneration, complicated conditional transgenic experiments (with the cost of breeding and keeping animals increasing in the time period due to barrier control), and large-scale proteomics and genomics studies, most recently including single cell sequencing. These expensive technologies are more expensive for neuroscience than any other discipline because of the difficulty of accessing the brain. The challenges and costs of undertaking translational neuroscience research have also increased considerably, today additionally including technologies like vastly improved structural and functional MRI imaging, neuro-microscopy, electrophysiology, optogenetics and organoids, which have become a central and expensive part of neuroscience research; use of iPS stem cell techniques, a relatively a new and significant expense; use of big data; 'omics' research – e.g. studies that incorporate large genomics databases; clinical trials for brain conditions, which have only become mainstream in this time frame; high failure rates of clinical trials and the high cost of clinical trials across therapeutic areas; the increasing role of patient advocacy groups in trials. Neuroscience costs are higher than those for Clinical Medicine: one blood test for biochemistry = £10; one MRI scan = £500. **Psychology** Over the past decade there has been a significant shift in psychology. Median published sample size has increased or is now increasing in most areas of psychology[1], and this trend has continued since REF2014, in part because of pre-registration and the use of power analyses to compute (large) sample sizes. An increase in 'real-world' studies, which are more complex to execute and often involve recruiting from relatively expensive populations (older adults, non-WEIRD[2] groups, clinical groups).

1 Fraley, R. C., & Vazire, S. (2014). The N-pact factor: Evaluating the quality of empirical journals with respect to sample size and statistical power. *PloS one, 9,* e109019.
Marszalek, J. M., Barber, C., Kohlhart, B., & Cooper, H. (2011). Sample size in psychological research over the past 30 years. *Perceptual and Motor Skills, 112,* 331-348

2 Western, Educated participants from Industrialised Rich Democracies.

Privacy legislation has impacted the cost of participant recruitment and data curation. In general, psychologists now work in larger teams, collecting more data in more elaborate ways, and performing more sophisticated analyses.

Each of these changes has direct consequences for the cost of producing globally competitive research. In addition, almost all of psychology has moved from a reliance on 'cheap' behavioural measures to techniques such as neuroimaging (particularly, fMRI) and genetic testing.

As new technologies have become available and scientific questions have evolved, psychology at Edinburgh has seen a significant shift towards cognitive neuroscience, with substantial cost implications. Psychology staff with primary cognitive neuroscience research interests have increased (see answer to question 2). Many others use similar methodologies. See question 3 for more details on the equipment required to support psychology research.

2. Changes in the balance of research activity between constituent discipline areas covered by Unit of Assessment 4.

Edinburgh's UoA 4 profile is and has historically been quite different from other HEIs in Scotland, partly because of choices to present the entirety of our neuroscience research as a coherent whole, where other HEIs have chosen to present (for example) stroke research within Clinical Medicine. We have consistently submitted stroke research within our neuroscience research since 2001, reflecting the close structural relationship as well as the continuum of research practice. This has disadvantaged these areas in terms of funding as this research – while in practice at least as high cost to deliver as anything within a clinical or pre-clinical context – has been awarded lower cost funding.

The balance of discipline areas in UoA 4 in Edinburgh's 2014 submission was not dissimilar to those covered in 2008 or in 2001 – at a ratio of roughly 2:1 neuroscientists and clinical psychiatry research to psychology research conducted in our College of Arts, Humanities and Social Sciences. Therefore there is a ratio of 2:1 on higher cost subjects compared with lower cost.

In RAE2001, our submissions included 17 staff submitted as part of psychiatry to UoA 2 (Community Based Clinical Subjects); 19 submitted as part of Neuroscience to UoA 3 (Hospital based clinical subjects) and 19 to UoA 13 (Psychology). In RAE 2008, 89.86 FTE were submitted to UoA 9 Psychiatry, Neuroscience and Clinical Psychology and 38.51 to UoA 44 Psychology. Our 2014 REF submission to UoA 4 covered clinical subjects within the neuroscience banner, including stroke research (77.78 FTE) and social, behavioural and clinical psychology research (39.5 FTE).

This balance has not changed over time and as has been stated we choose to present the entirety of our neuroscience research in one return because we believe in the added value of the coherent vision so illustrated. Weighting UoA 4 at a lower level than UoA 1 disadvantages this approach and this expensive discipline.

It should also be noted within psychology, staff with primary cognitive neuroscience research interests have increased from 5% in 1998, 30% in 2008, to 42% in 2018 – so within psychology, higher cost research is a larger share than in the past.

3. Changes in levels of support required by academics active in research in the disciplines covered by Unit of Assessment 4, specifically in terms of

- Research Assistants or equivalents;
- Specialist support staff such as technicians;
- Access to specialist research equipment, infrastructure and facilities.

We do not routinely collect data at the UoA 4 aggregation, so are unable to provide answers at exactly the data points requested; however the data below gives as illustration of changes over the last decade.

Research assistants

	UoA 9	UoA 44	UoA 4 - neuroscience	UoA 4 - psychology	Total

2007	76.82	18.13			94.95
2013			94	22	116
2018			235	36	271

Technical and support staff

	UoA 4 - neuroscience	UoA 4 - psychology	Total
2013	130	10	140
2018	95	22	117

2007 data is as submitted to RAE2008; 2013 and 2018 data are drawn from University of Edinburgh data, though restructuring between 2013 and 2018 mean that the data are not strictly comparable. Technical staff data is not available for 2007.

In terms of infrastructure and equipment, in neuroscience, as indicated in the answer to question 1, imaging and other technologies are central to Neuroscience research. Given the complexity of the experimental techniques above, the levels of support required are increasing. Research assistants or technicians are essential for animal experimentation, whilst the specialist equipment required for both basic and translational neuroscience is very expensive.

For example combining electrophysiology, live imaging and virtual reality environment hardware as is required for some of our cutting-edge work involves equipment with combined costs of more than £1 million. All this equipment has to be obtained on research grants, and for these grants the University is expected to provide 25% or more of the total cost.

In Psychology, since 2007, eyetracking and EEG laboratories, NIRS, perception-action, and ultrasound laboratories have been added to the equipment – with specialised technical support costs, as well as consumables costs.

Psychology researchers have access to MRI and costs of these studies are typically at least £450 per participant-hour.

By September 2019 psychology will have two staff members whose primary research is MRI-based, and several others for whom it is part of their portfolio. The increased influence of genetics in our personality and ageing research has also increased costs for testing, storage, and analysis of large datasets.

4. **Changes in the volume (ie number and/or size) of research grants won per researcher active in the disciplines covered by Unit of Assessment 4.**

	Total grant income UoA 4 disciplines	FTE	Income per FTE
2006-07	13,840,008	128.47	107,729
2012-13	18,044,138	117.28	153,855
2016-17	25,448,023	210	121,181

Our post-REF2014 analysis of income is only partially complete – data past 2016-17 is not available at UoA 4 aggregation, and we are aware of grants missing from 2016-17. However, this demonstrates that since RAE2008 there has been growth both in income and in the income per FTE.

The levels of grant support in neuroscience have increased hugely since 2008. Examples would be the $20 million Simons Initiative, £6 million of Wellcome Trust funding into myelin research, £15 million of UK DRI funding into dementia research, £4M from the MS Society and many individual grants. Philanthropic funding has also increased significantly. Over the last four years Neuroscience at Edinburgh has received over £170M in competitively won research awards.

	5. Any other sources of evidence that might illustrate any changes in the absolute costs of research activity in the disciplines covered by Unit of Assessment 4 since 1997-98. The cost of brain disorders in the UK has been estimated at over £112 billion[3] and with an ageing population and an ongoing rise in dementias this figure is increasing each year. Funding UoA 4 at a lower cost weight than UoA 1 undermines the importance of research in this area – and feeds the apparent undervaluing of mental health medicine against physical conditions. Furthermore, market analyses estimate the cost of undertaking neuroscience research will grow by over 3% p.a. between 2017 and 2024 – so the issues outlined in this paper will only become more acute in the next few years. Other factors driving the cost of research in these areas include increasing expectations of UKRI and Wellcome Trust for university contributions to equipment, increasing data storage requirements, open research and open access publication, and data storage costs e.g. of brain images.
University of St. Andrews	**1. Changes in research practice in areas covered by Unit of Assessment 4.** Changes in practice have been observed as follows, the impact of these is each described in the sections below. • Increases in neuroscience and more biological send of the spectrum in terms of research income and outputs. • Increases in the utilisation of expensive and specialised techniques, which incorporate access to high maintenance cost equipment.

[3] NA Fineberg et al. 'The Size, Burden and Cost of Disorders of the Brain in the UK' Journal of Psychopharmacology 2013

- Changes to costing of research grants (FEC, modernisation of research staff pay).
- Increases in data management costs and collection of 'big data'.
- Increased awareness and active involvement in large public engagement activities.

2. Changes in the balance of research activity between constituent discipline areas covered by Unit of Assessment 4.

The main changes seen within the Unit of Assessment 4 within the School of Psychology and Neuroscience in St Andrews has been the creation of the School itself.

Prior to 2012 this Unit comprised a single School of Psychology, with expertise in social, comparative, cognitive and evolutionary psychology. In 2012 we strategically integrated 4 neuroscience PIs from the School of Biology along with their research groups, and the benefits included enhanced opportunities for collaborative, multi-strand research and improved opportunities for postgraduate research training.

The successful introduction of a group of Neuroscientists from Biology highlights the changes in the breadth of the Unit across the UK. Our School now incorporates 4 very strong research groups: four domains: Origins of Mind; Social and Group Processes; Perception, Cognition and Action; and Cellular and Developmental Neuroscience.

The changes detailed above have led to a significant increase in the number of PIs within the remit of this Unit who work on animal models. Currently this relates to 41% of our PIs and over 50% of our other research staff. In 1997 this figure was much reduced, at 20% of PIs. This is a significant shift in the balance of the School and the Unit towards more costly research (see rationale below).

Whilst the balance across our 4 research groupings has altered the balance within some groupings has also shifted. The advent of advances in technologies such as fMRI, and the statistical analyses now employed to rationalise these techniques has led to a significant increase in the uptake of these 'expensive' assays of human brain activity. On the global scale publications utilising fMRI have risen exponentially since 1997 (Web of Science database (700 publications in 1997-8 vs 10,300 publications in 2017-18), see also https://doi.org/10.3389/neuro.09.063.2009). This increase is also mirrored when focussing on work undertaken in St Andrews (300% increase in publications).

3. Changes in levels of support required by academics active in research in the disciplines covered by Unit of Assessment 4, specifically in terms of

- **Research Assistants or equivalents;**
- **Specialist support staff such as technicians;**
- **Access to specialist research equipment, infrastructure and facilities.**

The increases described above have led to an increased need for specialist support staff in the areas of Research Technicians, Statisticians, Bioinformaticians and collaborations with external agencies that can provide these services is we cannot source in house.

For example, the increasing use of global molecular tools, such as RNA Seq or DNA barcoding (which are used frequently by PIs within the School) requires outsourcing of RNA-seq platforms, run by specialist technicians (at a cost of up to £300 per sample excluding VAT, which as to be paid on external contracts) and in addition payment for staff time at the in house Bioinformatics Unit. In 1997 these technologies were in their infancy, but are now the norm. This and other areas within the Unit require access to large data storage, which comes at a premium at most Universities.

There have also been significant increases in the need for specialised infrastructure and facilities. As

mentioned earlier there has been more than a doubling of PIs that utilise animal models in their research.

In addition users employing techniques such as those related to human fMRI studies have also seen **significant** changes in their costs. This is in part due to changes in per hour session costs and also changes in expected sample sizes. The expected sample size has risen from 20 – 60 participants per experiment.

Added to that, longitudinal components have been added into the expectations, with all the costs associated with dropout as well as additional scanner time, are multiplicative. Over the last 10 years this has equated to a significant increase in costs. Aside from this substantial increase in recent years the rise of fMRI studies on the whole has also significantly increased costs since 1997. However similar increases have been seen in allied fields, such as microscopy use or introduction of TMS technologies.

4. **Changes in the volume (ie number and/or size) of research grants won per researcher active in the disciplines covered by Unit of Assessment 4.**

Increases per se in the size of research grants has been significantly affected by the introduction of FEC rules in 2005. On average grants have increased by a factor of 3 since this time. This increase is only partly due to FEC. In addition the modernisation of research staff salary scales in 2006 has also had an impact. However, other important factors have also played a role – these have been identified above. The utilisation of more costly and specialised equipment and techniques, the increase in animal costs and the increase in expected sample sizes and longitudinal experimental designs (also relevant to a wide range of research disciplines within the Unit) have impacted on grant award levels. Each of these impacts: FEC, Staff salaries, technologies and animal usage have either begun to exist or have significantly increased since 1997.

	5. Other evidence Increasing emphasis has been placed on interaction with the public and the School has taken this very seriously. Whilst much PE activity can be relatively inexpensive the School has developed a long-term collaboration with Edinburgh Zoo, which includes an exhibit and research centre designed to enable research and act as a PE centre for excellence. Opened in 2008, the Living Links to Human Evolution Research Centre was created through a £1.6M investment.
Heriot Watt University	**1. Changes in research practice in areas covered by Unit of Assessment 4.** We have been increasingly using more equipment and of different kinds (e.g. including robots [which are very expensive to buy and maintain]). So, our research methods reflect contemporary technologies and techniques – as well as advancements in well-established methods like EEG (e.g. with the introduction of portable EGG). With the drive for interdisciplinary research we have good access to labs in Engineering (Virtual Reality Lab) and the Edinburgh Centre for Robotics robots, for social and developmental robotics. However, while the costs of maintaining these facilities usually lies with those disciplines; increasing costs of maintaining the collaboration and/or participation is required in Psychology. **2. Changes in the balance of research activity between constituent discipline areas covered by Unit of Assessment 2.** Heriot-Watt currently has 3 dedicated Psychology labs (an EEG lab, a Motor control Lab and General Psychology Labs, including a driving simulator and eye tracking equipment). These have been developed mostly with internal investment over the past 10 years. The investment amounts to less than £100k / year on average; however, the actual figure per year is much more variable i.e. some years may require investment in the £500k - £1M scale.

	The running costs for running 40 participants in the EEG are £905, as example of costs. **3. Changes in levels of support required by academics active in research in the disciplines covered by Unit of Assessment 4, specifically in terms of** • **Research Assistants or equivalents;** • **Specialist support staff such as technicians;** • **Access to specialist research equipment, infrastructure and facilities.** Our changes to levels of support include a full-time specialist dedicated Lab Technician who is in overall charge of the three Psychology labs (an EEG lab, a motor control lab and general psychology labs). We have 5 RAs funded from both Charity and UKRI grants who run experiments in these labs. This has remained at a similar level over the past 5 years. **4. Changes in the volume (ie number and/or size) of research grants won per researcher active in the disciplines covered by Unit of Assessment 4.** Grants won from UK Science policy sources have been increasingly competitive and appears to favour largescale imaging or biochemical investigations. The sorts of Psychology research undertaken at Heriot-Watt (behavioural, cognition, etc.) has increasing been funded from Charitable research funders. However, such grants are usually less able to make contributions to the indirect or infrastructure costs of research. This also means an overall drop in the total amount of funding over this period, while the number of projects funders has been much more stable. **5. Any other sources of evidence that might illustrate any changes in the absolute costs of research activity in the disciplines covered by Unit of Assessment 4 since 1997-98.**

	UG, PGR and PhD students in Psychology also require access to these labs, including these specialist equipment our technician's time and assistance in running experiments.

University of Glasgow	**1. Changes in research practice in areas covered by Unit of Assessment 4.** There has been a move away from computer-based studies with small numbers of participants towards more instructive and costly methods like neuroimaging and large-scale behavioural testing. **2. Changes in the balance of research activity between constituent discipline areas covered by Unit of Assessment 4.** The proportion of research activity in the areas of neuroscience and mental health has increased considerably. **3. Changes in levels of support required by academics active in research in the disciplines covered by Unit of Assessment 4, specifically in terms of** • **Research Assistants or equivalents;** • **Specialist support staff such as technicians;** • **Access to specialist research equipment, infrastructure and facilities** **4. Changes in the volume (ie number and/or size) of research grants won per researcher active in the disciplines covered by Unit of Assessment 4.** **5. Any other sources of evidence that might illustrate any changes in the absolute costs of research activity in the disciplines covered by Unit of Assessment 4 since 1997-98.** The value of awards announced in a particular year, as requested in section 4, can be quite uneven due to the total grant award being counted in the year it was awarded. A more informative indicator would be the research income (expenditure) for each year as is reported to HESA. Furthermore, as outlined in your introductory paragraph, the subject weightings are intended to reflect the varying

	cost of carrying out research in different disciplines and as such, the weightings need to take account of the relative cost of research between disciplines rather than changes within a discipline over time. Clinical medicine (UoA1) is the most relevant highly weighted discipline., Clearly, the cost of research within UoA4 remains relatively low compared to UoA1. The University of Glasgow therefore believes that the current cost weightings remain appropriate and reflect the relative cost of undertaking research between the discipline groups.