

# **Careering Out of Control: A Crisis in the UK Science Profession?**



A report prepared by **Science is Vital** at the request of the Rt Hon David Willetts MP, Minister of State for Universities and Science

5 October 2011

## FOREWORD

Dear Mr Willetts

We would like to express our thanks for your interest in our Science Careers campaign and your request for a summary of the issues that came out of our consultation. We are pleased to provide this report and we hope to be able to discuss this important matter with you further, in person, in due course.

With best wishes,

**Science is Vital**

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Vice-chair: Dr Evan Harris, Director, Campaign for Evidence Based Policy

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The views expressed by the authors are not necessarily those of their employers.

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## EXECUTIVE SUMMARY

Science is vital for the UK economy. A healthy scientific career structure, in turn, is crucial to maintain our strong research base, especially in a time of public austerity. Science is Vital, a grassroots campaigning group with the aim of protecting and championing science in the UK, recently conducted a consultation amongst a wide range of scientists in the UK to explore their views on the career structure of the profession.

Nearly 700 respondents, distributed across the spectrum of the scientific career, submitted written evidence – from students and postdocs to principal investigators, department heads, emeritus professors and Fellows of the Royal Society, representing more than 160 institutions across all four nations of the United Kingdom. We found that the top concern of these scientists was the career instability caused by successive fixed-term contracts and the shortage of permanent research positions. Other problems included issues of pay, mobility, balancing work with having a family or relationship, pressure to assess impact, and the fact that in many cases younger scientists are not allowed to facilitate their careers by applying for their own grants.

This exercise uncovered the widespread view that the scientific career structure in the UK is not fit for purpose. If the situation is not improved, we risk seriously undermining our research base and, in turn, imperilling the economy. Clearly, increasing funding for science in the next budget would significantly help ease the pressure. In the meantime, however, drawing from our respondents' ideas, we have proposed a number of solutions that we would like to see discussed among government, scientists, funding bodies and universities, including:

- The creation of more permanent research staff positions that are not principal investigators/lab heads
- More funding earmarked to help bridge the transition from postdoc to independent position
- More independent fellowships, and the abolition of eligibility criteria that effectively discriminate against older postdocs or those who have followed a non-traditional career path
- Increased opportunities for postdocs to apply for project grants as the named investigator in their own right
- The inclusion of early and mid-career researchers in ongoing discussions about the scientific career structure and funding issues
- Private sector contributions to scientific training
- Improved career advice for PhD students and postdocs

## BACKGROUND

### Science is vital for a strong UK economy

We live in a technological, knowledge-driven society. The UK has for many years reaped the benefits of an early, advanced scientific and industrial base that is coupled to strong communications and trading ties with the rest of the world. British science has a well-deserved reputation for being among the best in the world, and has long been able to attract and retain the very best home-grown and international talent. UK science is extraordinarily productive and efficient; pound for pound we lead the world in our ability to turn investment in science into high-impact scientific publications. A respectable number of Nobel Prizes are still awarded to British and British-trained scientists, and we are first in the G8 by proportion of papers as a percentage of GDP<sup>1</sup>. However, the career structure that underlies this success is unsustainable and, in the present financial climate, reaching breaking point.

Our current report complements that of Sir Gareth Roberts<sup>2</sup>, a 2002 review commissioned as part of the Government's productivity and innovation strategy. Roberts identified the lack of a clear career structure, and uncertain career prospects associated with work on a short-term contractual basis, as a major barrier to the recruitment and development of postdoctoral researchers. He also observed that uncompetitive salaries throughout the sector act as a disincentive to working as a contract researcher, and that low levels of pay lead also to problems recruiting and retaining permanent academic staff. Nearly a decade on, the issues Roberts identified remain very much in evidence.

### Career problems for UK scientists are endangering the whole profession

The training of new scientists used to be viewed as an apprenticeship, in which an established scientist ('lab head' or 'principal investigator' [PI]) would train and nurture both PhD students and postdoctoral researchers ('postdocs'). In return for supplying the world with original research findings and bolstering the career of the PI and the prestige of the institute housing them, the apprenticeship was meant to facilitate the progression of trainees into long-term careers as independent investigators in a university, research institute or industrial laboratory. While it should be noted that a subset of students and postdocs have always left this main track to pursue other science-related activities valuable to society – such as teaching, patent law, finance, science publishing and science writing, to name but a few – these positions do not usually require more scientific research training than that provided by a PhD degree, and in some cases, than by an undergraduate science degree. Therefore, most researchers who carry on as a postdoc do so because they desire a lifelong career in research. In the process, they acquire a wide range of key skills, and contribute their experience, talents and creativity to the research endeavour; collectively, their activities are utterly indispensable to the entire scientific enterprise.

The scientific career structure has always been competitive, but in recent times the system has become seriously unbalanced. The labour requirements of modern science have evolved a life cycle in which a PI nurtures young trainees in short generation times of three to five years. Therefore, by the end of a successful career, a typical PI with a large team could produce 60 or more potential replacements for the sole permanent academic position that he or she occupies. Over the past decade, this pressure has been exacerbated by an increase in the number of PhD students produced in the UK (from about 11,000 in 1998 to around 16,600 in 2008)<sup>3</sup>. Although PhD-level scientists are extremely valuable to society and are the lifeblood of science, the situation becomes untenable when the number who intend to pursue a research career far outstrips the supply of suitable positions. To make matters worse, the cash freeze for science funding in the last spending review, which has been estimated to result in an approximately 14%

cut in real terms by 2015 once inflation is taken into account<sup>4</sup>, will put severe pressure on the research base and opportunities for junior scientists.

A critical step in a young scientist's career is the transition from a postdoctoral post into a more permanent research position. Fellowships from the major funding bodies designed to ease these early and middle-career postdocs into their first independent position are scant, and hugely oversubscribed. For example, in 2011 the Royal Society offered just 40 University Research Fellowships across all scientific disciplines, and the success rate for the previous round was only 7.6%. University lectureships also rarely become available, and receive many applicants.

Candidates who are unsuccessful in securing a permanent position quickly face the erosion of their chances to remain in science. After a set number of years from receiving a PhD, a postdoc is no longer eligible for independent fellowships, which means that after this point, typically in one's mid-thirties, research experience actually works against the postdoc in his or her career progression. More experienced postdocs are more expensive to employ and may lose out to younger, cheaper applicants even when applying for postdoctoral positions because these are funded by cash-limited grants. The system effectively judges people against a ticking clock, rather than on their individual merits, and may particularly disadvantage researchers who have had non-traditional career paths, who have taken maternity leave or had childcare commitments, or who have bolstered their CVs and experience with a period in industrial research. Problems also arise when researchers suffer bad luck with a project that did not work out as planned (a common occurrence in the business of research); negative data can be valuable to the scientific community, but there is currently little incentive or reward for reporting it.

Permanent positions for research staff who are not going to become PIs would be appropriate for more senior postdocs. These roles would greatly enhance the effectiveness of an otherwise high-turnover research team and could give more opportunities to the UK's current legion of talented and experienced researchers. But the number of such posts, never very abundant in the UK, has also been shrinking. The net result is an ever burgeoning, ever aging cohort of postdocs on multiple successive short-term contracts, vying for a rarefied pool of bridging fellowships or permanent jobs. The vast majority of these will give up, move abroad or will become too expensive to hire and will simply drop out of scientific research altogether. This outcome constitutes a serious loss to science; in many cases, these "drop-outs" will have been successful and productive researchers working at the UK's top facilities.

It is, therefore, no surprise that morale amongst the scientific community in the UK is low. Worryingly, PhD students are now catching the mood: word is getting around that a career in scientific research is unlikely to be worth it. They hear about the poor job prospects, the low numbers of fellowships and grants on offer, the relatively poor pay and the instability of short-term contract existence. Many of them will be put off – and who could blame them? With the current excess of high quality postdocs, this might seem like a good thing, but it would not take very much for the pendulum to swing too far. If we lose a whole generation of young scientists, can we be sure we will be able to restore effective numbers in the future? The dedication of enthusiastic and talented young trainees, willing to work hard for relatively little remuneration, is crucial for the scientific enterprise – but has this goodwill been exploited too far? As UK science funding enters a period of slow decline, the long-standing problems of promoting careers in science are being brought into sharp relief.

## **STARTING POINT: The Royal Institution discussion**

The science careers problem was discussed at London's Royal Institution on 24<sup>th</sup> May 2011 at an event entitled "Science careers: has the science establishment let down young researchers?"<sup>5</sup> Dr Evan Harris chaired a panel in front of a large audience mostly comprising young scientists. On the panel were Dr Jennifer Rohn (Chair of Science is Vital), Professor Dame Athene Donald FRS, (University of Cambridge) and the Rt Hon David Willetts MP, Minister of State for Universities and Science. Members of the audience were passionate and articulate, raising a number of key issues and identifying problems with the scientific career structure that fall into the following seven categories:

- Relatively low pay for the amount of education and training required
- Having to move from city to city or country to country to follow and find jobs
- The prevalence of short-term contracts and the shortage of permanent positions
- The toll the career structure takes on families and relationships
- The way the science career structure works against people who take non-traditional paths, or who take time out to raise families or care for sick/elderly family members
- The fact that younger scientists usually aren't allowed to apply for their own grants
- The pressure to assess the impact of research

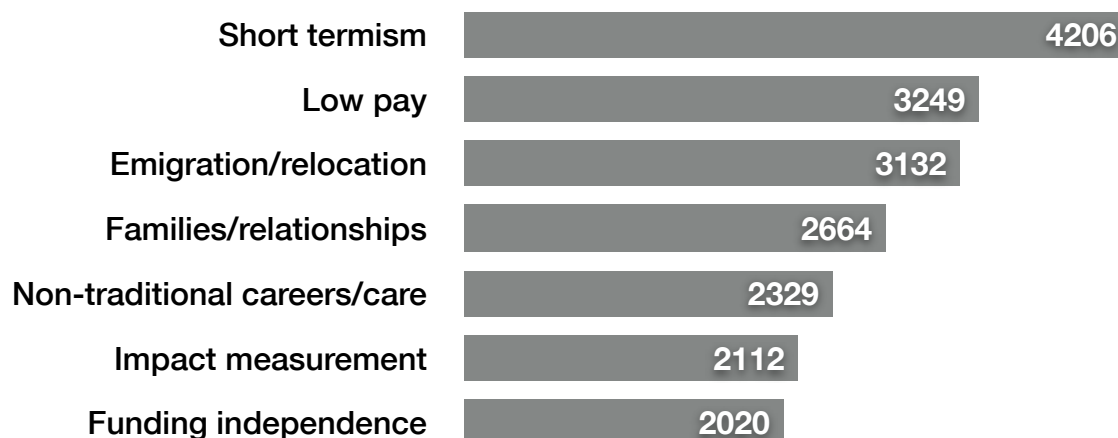
At the end of the meeting, the Minister stated that he would welcome a document from Science is Vital summarising the main points of contention coming from the scientific community. Although the diversity of opinion on the night was broad, the number of participants was, by necessity, limited. Moreover, the event was available only to those scientists who could attend an evening meeting in London. Science is Vital decided that the exercise would be much more valuable if it could be broadened to include as many UK researchers as possible, so that the views put across were more representative.

To this end, as summer drew to a close, Science is Vital made a concentrated push to solicit opinions, starting with a mail-shot to 17,000+ UK researchers who had signed the original Science is Vital petition in October 2010, and bolstering the call with social media amplification. In our call<sup>6</sup>, we asked UK scientists for two main contributions: participation in a poll, and the online submission of written evidence about problems with science careers and their potential solutions. Just 24 hours after our formal call, we had already received more than 400 pieces of written evidence. This rapid and robust response highlights just how important these issues are to the scientific community.

## RESULTS OF OUR WIDER CONSULTATION

### The poll

We asked respondents to identify which of the seven categories identified at the meeting (see above) they felt constituted the biggest problem with science careers. Because we expected that many people would have more than one career-related issue, we asked them to rank the issues in order of how pressing they were perceived. The results of the 744 individual responses are as follows (Figure 1):



**Figure 1: Poll results** Numbers are a score from a weighted calculation: items ranked first are valued higher than following ranks; the score is the sum of all weighted rank counts.

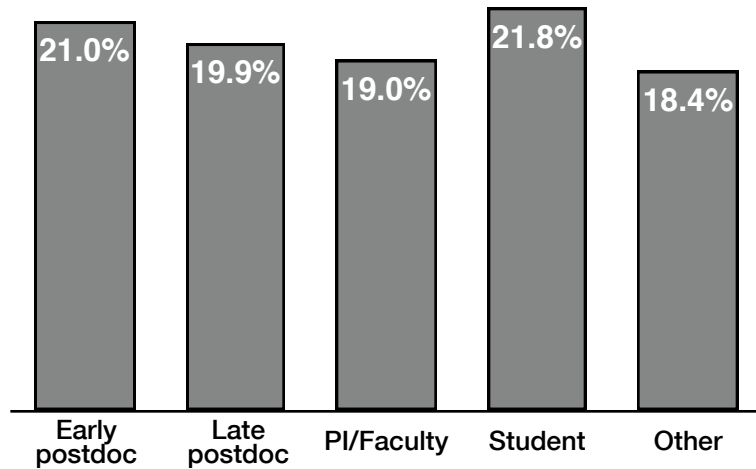
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This poll shows that all of the issues raised at the Royal Institution meeting are indeed perceived to be important, but the impact of short-term contracts is by far the greatest concern: a full 49% of respondents named this issue as the top problem.

### The written evidence submissions

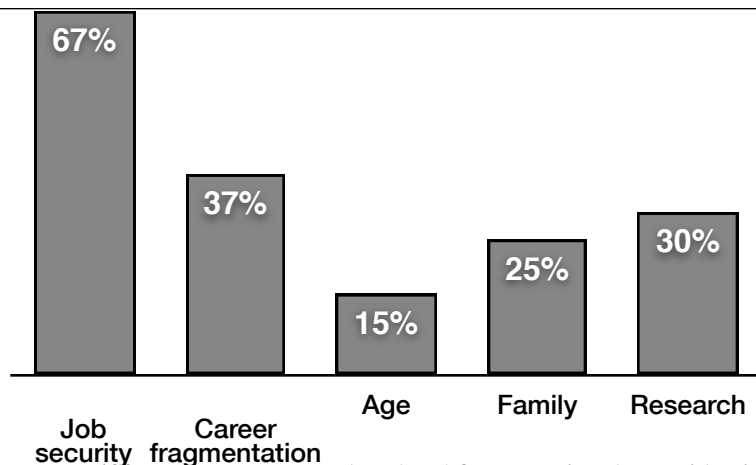
We received written responses from 676 scientists distributed across the spectrum of the scientific career, from PhD students and early-career postdocs through to longer-term postdocs, PIs, emeritus professors and Fellows of the Royal Society (Figure 2). Geographically, we received evidence from more than 160 institutions across all four countries of the UK – from Aberdeen to the Zoological Society of London, from Belfast to Cardiff. Although postdocs are the most directly affected by the issues we raise in this report, it is important to note that we received roughly equal numbers of responses from senior postdocs and established PIs. This shows that the problem is of concern to the entire scientific community, not just to a marginalised subset.





**Figure 2: Occupation of respondents** 675 people responded to our online instrument. Of these, “Student” includes PhD (18.1%), Masters (2.4%) and undergraduate (1.3%) students. “Other” includes ex-postdoc (not in research): 5.2%; staff scientist/RA/technician: 6.8%; other non-PhD scientist: 3.9%; other non-scientist: 2.5%.

The vast majority of submissions were balanced and passionate, as researchers and ex-researchers from all walks of life shared their personal stories. Scientists are often mis-characterised as rather dry, objective individuals, but we were nevertheless astounded by the depth of feeling and anxiety encapsulated in their words. Although respondents repeatedly described their love and enthusiasm for the pursuit of research, in aggregate these responses represent a formidable outpouring of frustration, dissatisfaction and genuine regret from the UK’s best and brightest, both young and old. The responses were also remarkably consistent in content, and we identified a number of interlinked themes that we want to highlight (Figure 3 and in more detail below).



**Figure 3: Top themes** 432 responses were analysed and five recurring themes identified. The percentage of respondents who mentioned each theme is shown. Respondents often had multiple concerns.

### ***Economic waste***

Many of our respondents pointed out the waste inherent in a system that forces out older postdocs, trained for many years at great expense by taxpayers or research charities, only to replace them with younger people who need to be trained up all over again.

A postdoc had this to say:

I have been a postdoc for 8 years now, and I am thoroughly enjoying it. I have made contributions to my field, and have supported my University by teaching, but my publication record isn't strong enough to secure my own funding or to get a lectureship. This means I am very likely to have to leave academic research by the end of my 3 year contract. That means that 8 years of education and 8 years of postdoc experience, which were mainly paid for by taxpayers' money and charity funding, are lost. If I had my way I would [remain] a postdoc and keep doing the job I'm very good at. Unfortunately that is not possible, as there are no permanent positions for postdocs, and thus more money will be spent instead training less experienced people up to do the same job, [who] then again will have to leave research. It seems a very wasteful system.

Another postdoc agrees:

I've been a postdoc for nearly 12 years now (and a fairly productive one at that – put it this way I would definitely be returnable at international level in the forthcoming REF). I would love to stay in science but am struggling with getting a permanent position – there just aren't many jobs around and I've been told that each lectureship I've applied for is getting upwards of 100 applicants. I also cannot apply for most academic fellowships as they have time limits of usually 6-8 years post-PhD.

I'm not actually too worried about becoming a PI. I enjoy being a postdoc and would happily stay in this type of position except that short term contracts of generally only three years make this impractical as a career choice. In addition many institutions/groups are reluctant to take on senior postdocs as we are too expensive and many grants awarded provide for only a junior postdoc salary. This means that highly qualified senior postdocs repeatedly have to take pay cuts.

All this being the case I am on the point of feeling that I have no choice but to leave a career in science that I really enjoy and am good at. I am certainly not unique in this. It seems crazy to me that many highly trained scientists are making this decision because of the lack of a sensible career structure in academic science. This can't make economic sense!

### ***Lack of job security***

The main concern, raised by 68% of respondents, was job security – which supports the result of our poll. Many respondents pointed toward the lack of mid-career positions for able and productive scientists with specialist expertise who are not PIs. In reality, many excellent researchers are forced to leave science, not because they have been unsuccessful or unproductive, but because after two or three postdoctoral contracts, their specialist expertise makes them too expensive to retain in a system geared toward short-term goals. Instead, the system is fuelled by exploiting new recruits (whose own career prospects will in due course be similarly limited).

The 2008 Concordat to Support the Career Development of Researchers<sup>7</sup> recommended that all research staff be employed on open-ended contracts. According to a 2011 survey by the research staff organisation Vitae, however, a full 77% of the 7,000+ respondents reported being on a fixed-term contract<sup>8</sup>. In reality, even those on open-ended contracts usually find those contracts terminated when their PI's grant money runs out. With the exception of a very few stellar researchers who are able to win successive personal

fellowships, and the small number of scientists who gain academic posts, opportunities to remain employed as a research scientist beyond one's early forties are extremely limited.

One successful PI put it like this:

Scientific career structures are too pyramidal. We need lots of PhD students and postdocs to do the research, but we don't have PI jobs for them to go on to. This wouldn't be a problem if there were non-PI, staff scientist jobs, but there aren't. This means that anyone who ultimately lacks the skill set and sheer luck to make it to PI is wasting their time, even though they may be an excellent bench scientist. It also means that skills and experience are constantly leaching out of science as people fall off the pyramid, which is mad considering that the taxpayer has spent a fortune enabling people to acquire those skills and experience. Imagine if teaching had a career structure where you either made it to head-teacher by 40 or you left the profession, and as a result almost [all] teaching was done by vast numbers of newly qualified teachers hoping to make it to head.

In a similar vein, Professor Mark Marsh, director of the world-leading MRC Laboratory for Molecular Cell Biology in London, said:

The scientific career structure needs to be reassessed. At one time there were opportunities for skilled scientists to gain long term or permanent posts as senior scientists/technicians playing a vital role in the running and continuity of labs. Many of these posts have disappeared as grant funding and HEFCE funds have been squeezed, so that the career options have become increasingly narrow: grad student, postdoc, tenure track academic/PI, tenured academic/PI. Not everyone wants to be group leader, yet they have skills that are highly valuable to science.

Professor Emeritus Uta Frith, FRS, said:

As an Emeritus Professor I can look back on a golden age for science careers. It makes me sad that now young researchers are in a far less favourable position despite showing superior training, knowledge, communication ability and ambition compared to the standards of my own generation. I now worry about recommending a career in science even though society needs more scientists and scientifically trained people in general.

The system is beginning to break down as senior scientists find it increasingly difficult to recommend scientific careers to promising students.

Scientists employed on short-term contracts are often excluded from applying for funding in their own right. These restrictions are applied either by University regulations, which restrict applications to only those in tenured positions, or by funders imposing stringent eligibility criteria on applications, typically limiting them to early career researchers or to experienced PIs. But demonstrating the ability to attract and retain research funding is a vital requirement for career progression.

A respondent writes:

While there are a good many things that could be done to encourage careers in science in the UK, it seems to me clear that by far one of the easiest would be to remove [a UK Research Council]'s restriction that only teaching faculty can be PIs on grants. I simply can't imagine a reasonable reason for this limitation. Having taken a less than conventional track, after my PhD, I did a postdoc and then spent [about a decade] in industry. During this time I [managed multimillion pound projects]. However having decided that I wanted to move back to academia and taken a research post at a UK I find I cannot be the PI on my own applications to [the Research Council]. This is made all the more ridiculous by the fact that I am named as a PI on current multimillion pound EU grants.

### ***Career fragmentation and lack of continuity***

Another key concern, raised in 37% of our responses, was career fragmentation. Short-term contracts may mean moving between labs to new projects. While junior scientists, immediately post-PhD, have a good range of transferable skills and can often benefit from this process, the highly specialised skills of experienced postdoctoral researchers are typically tailored to specific research environments. Experience with specific facilities and equipment is squandered and carefully constructed teams are disrupted when researchers are obliged to move on when the funding runs out. Although fresh blood can invigorate a team, the constant cycling of new people through labs on short-term contracts is detrimental to productivity as expertise is lost and has to be constantly refreshed. The addition of even one permanent researcher to the team could in many cases make a big difference to a lab's productivity.

A PI explained:

The major problem is the loss of continuity: specialized skills acquired in particular by postdoctoral scientists need to be passed on from one 'generation' of scientists to the next but the current uncertainty means that experienced postdocs cannot be retained or are simply finding more secure jobs elsewhere. There are now fewer people in the lab who can train PhD students in these skills with the result that the most advanced techniques are having to be re-learnt at a great loss of time and money. In the distant past, permanent technicians within each lab would have been able to do this.

Matthew Freeman, Professor at the MRC Laboratory for Molecular Biology in Cambridge and FRS, said:

There is a valuable place for a small number of permanent research positions in a lab/department. This can be senior people with huge experience who can provide continuity and training for more transient team members. These posts used to be funded by HEFCE money but there's now much less money around. If they are grant funded they are, by definition, not secure. Ways of providing a modest number of such posts should be investigated but I don't think this will do much to alleviate the bigger problem.

From the postdoctoral perspective:

I have been a postdoc for [about two decades]. Along with several of my senior postdoc colleagues, I am facing redundancy this year. This is a terrible waste. My [postdoc] colleagues, all in their 40s and early 50s, are not complacent in their jobs (one argument proposed against giving postdocs permanent jobs) but are highly motivated, intelligent, experienced scientists. As well as carrying out experimental work they take on responsibilities for training students, managing projects, preparing manuscripts, communicating with collaborators, etc. These contributions are not officially recognised, and instead we are seen as temporary staff with no status, little respect from our academic colleagues and no authority. Many of us do not want to follow academic career pathways, but would welcome a research management position complementing the role of the academic. With increasing teaching and administrative pressures on academics nowadays, university research would benefit greatly by the creation of a layer of permanently employed research staff.

A number of our respondents pointed out that the requirement to compete regularly for funding is a wasteful distraction from scientific research. With the proportion of successful applications already small and diminishing, PIs are obliged to spend a substantial amount of their time writing new applications, many of which are destined to fail. Their postdocs, meanwhile, need to start looking for new positions in the final year of their short-term contract, a process that inevitably distracts from the business of research. The short-termism of much of scientific funding diminishes productivity for PIs and postdocs alike. Also, because there is little hope for an ongoing career without independent funding, some scientists are compelled to seek a PI position regardless of their aptitude for the role.

A postdoc noted:

I work in a world-class research group dealing with real world problems that have good potential commercial applications as well as being based on ground breaking scientific principles. We have no permanent funding or permanent full-time research staff. The group will cease to exist (along with my job) in six months time unless more short term funding is found. We are hobbled by uncertainty and short-term-ism which means our senior staff do nothing apart from scrape around for money while our postdocs are forced to look for work in new groups long before the funding ends. This means that even IF new funding is found we cannot keep the group together and build on our expertise and success. I am sure we are not unique in suffering these problems. How is this useful?

A principal investigator wrote:

I have had several good postdoctoral scientists working for me during my academic research/teaching career. The latest one, [name redacted], is an extremely talented research scientist who has pioneered [a highly specialised and difficult physics technique]. This work will have huge implications for many areas of technology, one obvious example [is a very useful and economically important application]. [This person] has kept his career going over the last 15 years, but now his scientific future is threatened by lack of funding and consequent dearth of suitable postdoctoral opportunities; this is particularly disappointing given that his work is at a breakthrough point; unless something changes the UK is about to lose its significant lead in this important and promising field.

### ***Pressure to emigrate***

Although science has always been a global enterprise with an itinerant component, and experience abroad is invaluable, it is ultimately crucial for the UK economy to be able to attract and retain the best scientists, both foreign and home-grown. Young British researchers typically enjoy and benefit from a stint abroad, but many would like to settle back in their native land. A number of respondents (17%) told us that they or their colleagues had moved from the UK or had contemplated such a move. Many respondents regard North America, Australia, Germany and some other European countries as more attractive places to carry out science in the current climate.

A postdoc had this to say:

I had a successful PhD, with numerous publications, from [redacted] and many within my department encouraged me to apply for various fellowships and advertised postdoctoral positions given my track record. After 4 fellowship applications and 3 applications for advertised postdoctoral positions I was still without a research job in the UK. ... If it were not for the funding available outside the UK however I would not have been able to obtain a job immediately following my PhD and therefore would have had to look outside of science for appropriate employment. It is highly likely that when looking to become an independent researcher I will look outside of the UK for employment unless the conditions within the UK improve relative to other countries in the near future. This would not be a decision I would take lightly however as I would ideally like to be based in the UK.

A professor said:

The changes in the last 4 years have had a profound effect. We have returned to a situation where the UK is seen as no longer the place to do science. Continental Europe is increasing investment, take for example France and Germany. Yesterday I received out of the "email blue" a request from an eminent Chinese [scientist], whom I have never met, asking me to make him aware of any good PhD and postdoctoral scientists

who would be interested in taking positions in China. He seems to indicate that he will take anyone who is good and can without question fund them. I have no alternative in the present climate but to tell those about these opportunities, nor should I consider, or would I consider, hesitating if I knew that they would gain experience there and then be able to return to the UK. But I am no longer able to reciprocate to him, or anyone else in the world asking for their bright young postdocs and PhD students.

### **Family life**

Many of our respondents (25%) pointed out that the prevalence of short-term contracts and the regular requirement to move between institutions and countries to continue with their careers placed a huge strain on family life. Pressures result from the requirement to be able to relocate every few years (particularly difficult for couples and parents), relatively low postdoctoral salaries, and the requirement to work long and antisocial hours to gain the competitive track record needed for career progression. Many women respondents argued that they were disadvantaged by the current arrangements. Although fellowships and grants do make some allowance for time off to have children, maternity leave – and time lost to child-caring afterwards – is particularly difficult to reconcile with the requirements of fixed-term, externally funded contracts.

One postdoc shared this:

Being a 28 year old female scientist I am more concerned about what effect having children will have on my career. I imagine that I will do another 4 years of post doc work before looking for a permanent position. If I had children before getting a permanent position (this would require at least 2x9 months leave) I would worry that the time I had missed would ruin my chances of ever getting a permanent position. If I got permanent position and then had children I would worry about not being able to do my job properly. Academia is not like other jobs, where you go on maternity leave and someone else takes over your job. There would be nobody there to apply for my funding or to employ PhD students for me. I only have to look at the male/female split in permanent staff in my institute. There is not a single permanent female member of staff that has children. This is in contrast to the PhD/postdoc split being approximately 50/50 male/female. The British government has spent many thousands of pounds on my education from school to PhD. If many women such as myself find that after having children they are unable to return to their careers, this is surely a huge waste of skills and money.

A woman who left research permanently after a postdoctoral position said:

[A] downside to the constant moving of contracts is that I missed out on full maternity pay because I'd had to move contracts and hadn't been in my current position long enough. Fitting children in with short term contracts is very hard – you've got to be in post for 6 months to get full maternity pay, and then stay for at least 6 months afterwards as well – that's a full year of your contract, and mother nature is rarely predictable so it is a problem...

A professor describes the hard choices her colleagues have had to make:

[The] women postdocs in my group have found it very demanding to meet the requirements for publications and spend enough time with their families. Most have opted to work 2 or 3 days a week and struggled to make an impact with their research compared to male colleagues who were able to do more substantial research and publish in higher impact journals.

I think better child care would not necessarily have helped as these women were highly motivated to pursue careers in science but, quite reasonably, found that they wanted to spend significant amounts of time with their children. I think there should be more

schemes which support women returning to their careers after 5 or 10 years absence to look after their children.

It is very upsetting to see these talented women struggle to return and then abandon the attempt to take up some other career that doesn't allow them to use all their skills.

A PhD student added:

The job hopping required by postdocs at present puts extreme strains on family life, potentially requiring early career scientists to ask for significant career and home sacrifices from partners and children. I have already asked this twice from my partner – once so that I could do my PhD, and again to move to the US with no guarantee of a job for her, let alone career progression. I don't know how many more times I will be able to ask...

### ***Experience is detrimental to career progression***

A number of our respondents emphasised that the system is weighted against experience: the longer a postdoc has been working on short-term contracts, the harder it is to continue. Fellowship eligibility requirements are skewed towards people who are within a set number of years past their PhD vivas, and older postdocs are deemed 'too expensive'. With a glut of younger postdocs swelling the ranks behind, the system encourages discarding experience in favour of cheaper and often less proficient options. It is safe to say that in very few other professions would years of experience and enhanced expertise count against a prospective employee.

Funders and PIs alike are pressed to produce 'impactful' research in the short-term, but are not encouraged to consider the long-term costs of losing highly skilled scientists from their workforce. This short-term thinking means that they undoubtedly waste resources training and retraining an endless stream of new and inexperienced recruits. Pressured by a limited budget, funders feel they have no choice but to routinely constrain the staff component of grant applications, forcing PIs to choose between a cheaper (less experienced) person for the full term of the grant or hiring someone more experienced for less time. Although applicants often seek to justify the need for hiring a more experienced person, in practice, these requests can be ignored.

Jordan Raff, Milstein Professor of Molecular Cancer Biology at the University of Oxford and President of the British Society for Cell Biology, put it like this:

The key point in my opinion is for the funding agencies to recognise that senior postdocs are worthy of long-term support within a lab. It is true that these postdocs' future is then tied to the ability of their boss to maintain this funding (or their ability to transfer their skills to another lab if that funding dries up), but, if it was accepted that these people should be funded on grants, this would be a reasonably attractive long-term career. I do know of several senior postdocs who have followed this career, but there are not many of them, and they are continually worried that their boss will need to replace them with younger, cheaper postdocs should the funding agencies question their usefulness.

Another professor notes:

I am very concerned about the career structure for young scientists and the current lack of prospects. I have outstanding postdocs in my lab who are just beyond the 7-year limit for most early fellowship schemes. The current fellowship system is entirely biased towards scientists with high profile papers shortly after PhD. A less steep trajectory with quality publications building over time can result in scientists with greater maturity and greater potential and yet the system essentially excludes them. With the decline in numbers of positions overall, these exceptional individuals will be forced to leave science.



## CONCLUSIONS AND PERSPECTIVES

A PI at a large university voiced an opinion with which Science is Vital agrees very strongly, namely that the careers problem is endangering the UK's scientific competitiveness:

I think the most telling comment on the changes to the academic career over the past 20 years can be highlighted by the answer to a single question. When I ask my colleagues whether, given the experiences they have had and the outlook for science funding and job security, they would choose academia as a career choice again? The answer is invariably NO. This attitude is being transmitted loud and clear to postdocs, PhD students and undergraduates. Unless government changes the landscape to make academia an attractive career the UK will fall off the map as a world leader in education and science innovation. It's as simple as that.

This viewpoint was a common theme in the submissions to our call for evidence. Clearly the present system is unsustainable. We are doing PhD students a disservice by training them and pretending that there are good career opportunities in UK science. At the same time we recognise that there will never be the funds to direct even a large fraction of the current numbers of PhD students into scientific careers. Something has to give, both to improve the performance of UK science and to maximise the return on the investment – in terms of money and effort – in younger scientists. To address these problems, we propose ideas that would (1) provide more opportunities for pre-existing skilled scientists who want to stay at the bench, and (2) give PhD students more suited to non-research jobs an earlier, but positive, exit from the academic system before they get trapped in the postdoctoral holding pattern. Some of these goals could be achieved by reassessing where funds are currently allocated.

Below, as a basis for further discussion, we list a number of practical ideas for improving the system as a whole:

- Create a means to employ more talented postdocs as permanent research staff
- Reallocate more bridging funds to allow postdocs leeway when making the difficult transition to independence
- Restructure existing funds to allow more independent fellowships, and abolish arbitrary eligibility criteria that work against older postdocs and those with a non-traditional career path: judge each applicant on his or her own merits
- Increase opportunities for postdocs to apply for project grants as the named investigator in their own right, so that they can take charge of their own destinies
- Include more early and mid-career researchers in ongoing discussions about the scientific career structure and funding issues, instead of confining these to the ranks of the 'great and the good'
- The private sector benefits significantly from publicly trained researchers skimmed off from academia: if these sectors contributed more to their training, more public science funding would be freed up for the academic community
- Provide improved career advice for those starting a PhD (and for those nearing the end of their projects). The myth that a PI position waits for all is needs to be corrected. Realistic and positive advice about the alternatives would partly address the pyramid problem by constraining the number of entrants



In the longer term, we also think it is crucial for the Government to increase science funding in the next budget cycle, which would significantly help retain the talented scientific workforce that makes our science possible.

In conclusion, we believe that a larger discussion of these issues and their possible solutions needs to take place among all stakeholders: government, scientists and the funding bodies. With Government support, Science is Vital would be happy to organise such a round-table event.

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