

Science and Gender in Academia – Obstacles and Interventions

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1 Introduction

The basic facts are obvious: women are not represented at the highest levels of the scientific academic ladder in the same numbers as they are at the undergraduate level. The reasons for this observation are less obvious because multiple factors play a role and which dominate depend on both the particular scientific sub-discipline under consideration and the individual. So, if there is no simple contributing factor there will equally be no simple solution or set of actions which will transform the situation.

Within the UK, the Athena Forum (and its predecessor the Athena Project), which I chair, tries to tease out and then disseminate best practice. It is not an organisation with much cash, nor in any sense 'power', but it can use its influence to effect change. In this article I will discuss some of the issues I perceive together with the activities I have been involved with, both locally and nationally. It should be noted that this will necessarily represent a fairly parochial UK approach, and some differences may be expected to arise between countries as well as between disciplines.

2 History and Context

If I look at the series of historical photographs of researchers in my own department in Cambridge (the Physics Department, known as the Cavendish Laboratory), even at the start of the 20th century there were a few brave women standing there, in clothes that seem totally unsuitable for any kind of serious lab work. The depressing thing is that the proportion of women changed so slowly. Starting in 1903 (the first exhibited photograph) and for the next 50+ years, the percentage of women fluctuated between 0 and ~10%; even now the proportion is probably only ~25%. So women were not excluded, but their entrance into research was not facilitated, they would have had to overcome personal and cultural barriers to be allowed even to enter research at the lowest level and, had they wanted to marry, would immediately have been expected to drop out. By the time I

became an undergraduate in Cambridge in 1971, numbers had still barely edged up. In my graduating class there were 8 women, but there were ~100 men. In the practical classes I might well find myself the only woman in the room. No one told me I shouldn't be there, but isolation is a powerful driving force tending to make minorities feel uncomfortable and unsupported. This is a point I will come back to.

Thus we see that the first critical step for the potential female scientist is enabling and encouraging them to enter university science education at all; we must separate working out how to interest more girls to start in the physical sciences from actions that may subsequently help to retain those who do start. For many, their experience of high school science simply puts them off. There will be multiple factors that come into play including stereotyping; expectations of their family, friends and teachers; and inherent interest in the subject. Whether or not brains are hard-wired differently for boys and girls from birth, the reality is by 15 the interests and motivations of boys and girls are different. This was revealed by the cross-cultural project on young people's views about science and technology carried out by ROSE (The Relevance of Science Education study¹). The following findings all come from this work, but other studies reveal similar conclusions; the differences between boys and girls are most marked in the developed world. This study found that, on average, boys at 15, across all cultures, are more interested than girls in topics such as how the atom bomb and diesel engine work, whereas girls favour studying things like plants and what we need to eat to keep healthy. Boys on average want a job where they can build and repair things and girls in general do not; girls, on the other hand, show a strong interest in working with people, which the boys do not share. Whatever has caused this difference by the age of 15, it is likely to mean that girls – on average - are less likely to want to pursue a degree in the physical sciences and engineering. For biological subjects the trend is reversed at this educational level. These findings of course say nothing about the individual.

¹ <http://www.ils.uio.no/english/rose/network/countries/norway/eng/nor-sjoberg-issi-2007.pdf>

Within the UK we can see this very clearly in Figure 1 (taken from a Royal Society's 2006 report²). What is also clear here is that the imbalance in numbers of male and female students are tending to increase over time in all subjects except physical sciences.

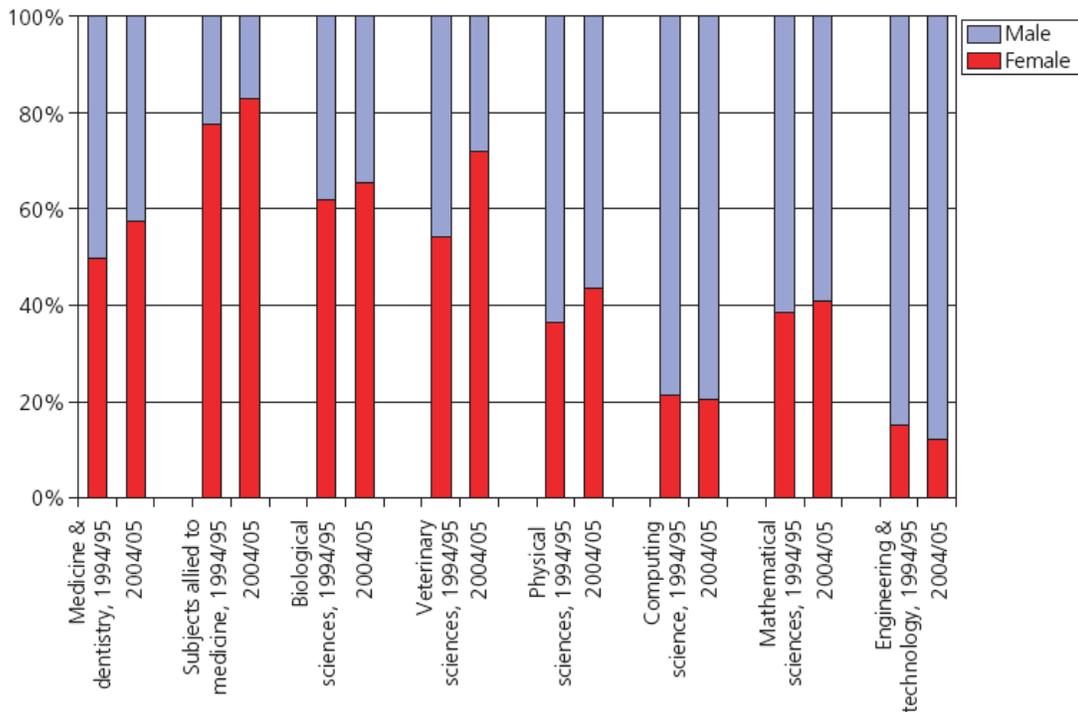


Figure 1 First degrees obtained by UK-domiciled students in selected STEM subject areas by gender, 1994/5 and 2004/5 (data from Higher Education Statistics Agency)².

The leaky pipeline is a well worn phrase, but it describes admirably what happens to the female population as they move from university through to researcher and finally tenured academic. The exact form of the 'leak' varies from subject to subject. Using UK statistics, my own subject, physics, starts off with a low number of undergraduates (~20%), but this drops to around ~16% for researchers and a comparable figure (which steeply rose after 2003) for lecturers. The current figure for professors is, however, only 6%. In the biological sciences the percentage drop-off is much worse: more than 60% of the first degree students are women, this figure has dropped below 50% for PhD students and to

² 'A degree of concern? UK first degrees in science, technology and mathematics

~30% for lecturers. At professorial level the figure is only 15%. So, in trying to interpret the leak and plug it, one has to factor in differences in subject as well as level. A very interesting comparison was made between chemistry and biochemistry research students in the biosciences³ which found that for the biochemists, in contrast to the results for chemistry PhD students, there was no evidence that a significant proportion of women were deterred during their PhD from entering a research career in the molecular biosciences. Rather, many female molecular bioscience respondents had never intended to remain in research. In chemistry, the equivalent survey⁴ found that whereas around 50% of female PhD students had intended to pursue academic research when they started their PhD's, that number had dropped to ~ 33% by the end (for men the comparable figures were 44% and 36% representing a rather less dramatic loss of interest in an academic career). However, chemistry in the UK seems to have some particular issues associated with it for both early career researchers and women of all levels, as identified in the EPSRC's recent International Review 'International Perceptions of the UK Chemistry Research Base'⁵ which stated:

- 'Support for ECRs and established researchers [is] not geared to enable adventurous research.
- [The] Future is hampered by its lack of diversity within the established research community. The singular most distinctive signal sent to the International Review Panel was the failure of the various units visited to highlight their women faculty.Apparently, few of the institutions were willing to "risk" reputations by advancing a woman as a spokesperson. '

That there is an overall upward trend in all subjects and at all stages of career progression for numbers of women is at least encouraging (see Figure 2a for the situation in Physics in the UK at different grades and Figure 2b for UK data at professorial level, again based on HESA data), but there is clearly a very long way to go even without aiming at such a simplistic target as 50:50 representation at professorial level. What we need to aim at

³ http://www.rsc.org/images/MolecularBiosciences08_tcm18-139859.pdf

⁴ http://www.rsc.org/images/ChangeofHeart_tcm18-139211.pdf

⁵ <http://www.epsrc.ac.uk/pubs/reports/Documents/ChemistryIR2009.pdf>

(and of course this means the target is extremely difficult to define) is that women are not lost to the academic profession for the 'wrong' reasons ie because they are forced out by unsupportive colleagues and workplace environment or the challenges of balancing family and career; what percentage of women that is will vary from subject to subject given the variation in the number of women entering university courses by discipline that we have already noted.

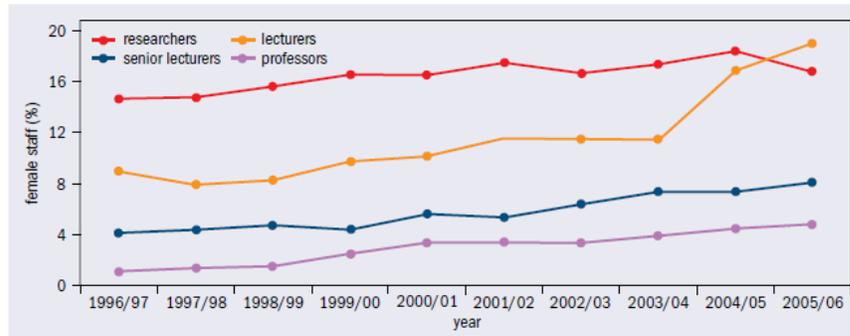


Figure 2a Trend in gender profile in Physics over the last decade by percentage of women by individual grade (HESA data 1996/7 to 2005/6)⁶

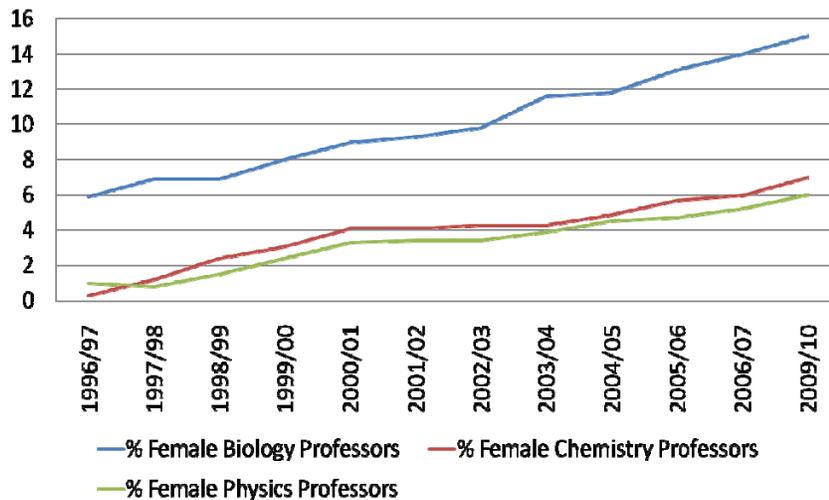


Figure 2b Trend in the percentage of professors in the UK in different subjects (HESA data),

⁶ http://www.iop.org/publications/iop/2007/file_42651.pdf

3 Obstacles

3.1 Introduction

The obstacles are in many cases self evident, but nevertheless worth rehearsing here to help inform the sorts of actions the Athena Forum, and others, pursue. I will adopt the position that explicit discrimination is sufficiently rare (and can be explicitly dealt with) that this should no longer be considered a major obstacle. Others may disagree. So my top ten list of obstacles are, in no particular order:

- 1) Family
- 2) Work life balance
- 3) Isolation
- 4) Lack of mentoring
- 5) Lack of confidence
- 6) Lack of role models
- 7) Lack of support networks
- 8) Unconscious bias acting against them
- 9) Stereotyping
- 10) Bullying and harassment

I will group these for further discussion and consider 1-2 together, 3-7 together and 8-9 together. Item 10 is a separate and completely invidious sort of problem, which good management should – but often does not – be able to resolve and eliminate. There can be a very damaging cumulative effect upon women of many small and petty instances. It is completely unacceptable, and is of course not just a problem for women, but where management and leadership is weak it can affect many people to everyone's detriment. And of course it may be the leadership that is explicitly the problem. In Greenfield's report for the UK Government in 2002⁷ we find the following remark quoted from a chairman introducing a senior female academic on an international committee: “And [committee member] here will add some glamour to the discussion”. Or, my own personal *bête noir* from a chairman (more than once, with different chairmen)

⁷ http://extra.shu.ac.uk/nrc/section_2/publications/reports/R1182_SET_Fair_Report.pdf

'Gentlemen.....', and it is so exhausting trying to think of ways of pointing out the implicit belittling of the woman or women in the room with that remark, without coming across as that oh-so-unfeminine word of 'aggressive'.

More fundamentally and seriously, there is the put-down in an ongoing context. For instance, Meg Urry (a US astrophysics professor at Harvard) said in an article in the Washington Post in 2005⁸ :

'About a decade ago, frustrated and alienated, I approached the director of my institution to ask about special management training for women: Maybe there were tips that would help me navigate the foreign waters in which I found myself. He didn't seem to understand. I said, "You know, it's like being the red fish in the sea of blue fish -- I want to understand the blue-fish rules." "Oh," he answered. "Maybe it's not your lack of training, Meg, maybe it's just your difficult personality."

Probably most women face this kind of insult by implication at some point in their career and over time it certainly constitutes harassment. What is so worrying is that when it comes from the top it is almost impossible to counter or fight back. Often the senior management has no appreciation of the effects of what is going on at low levels. As the then president of MIT said in the forward to the ground-breaking MIT report on the status of women faculty at MIT⁹:

'I learned two particularly important lessons from this report and from discussions while it was being crafted. First, I have always believed that contemporary gender discrimination within universities is part reality and part perception. True, but I now understand that reality is by far the greater part of the balance. Second, I, like most of my male colleagues, believe that we are highly supportive of our junior women faculty members. This also is true.'

It is incumbent on the leadership of any organization, in higher education or outside, in the sciences or wider, to stamp out bullying and harassment. However, we are a long way

⁸ <http://www.washingtonpost.com/wp-dyn/articles/A360-2005Feb5.html>

⁹ <http://web.mit.edu/fnl/women/women.pdf>

from having achieved this goal, but because it is not specific to science and gender I will leave it here.

3.2 Family and Work-Life Balance

Let us now turn to work-life balance and the perceived 'impossibility' of combining a successful academic scientific career with being a mother. This attitude is still prevalent, despite many counter examples highly prominent in academia and indeed the media. The Institute of Physics Report on Women in University Physics Departments¹⁰ stated

'Perhaps the most depressing aspect of the visits arose from meetings with female RAs and postgraduates, who were seen as a single group. Although they were often lively, enthusiastic and obviously enjoying their work, there was a widespread feeling that a successful academic career was not compatible with having a family'.

In the USA the situation is compounded by the continuing absence of paid maternity leave, the leave entitlement merely being up to 12 weeks unpaid parental leave in a year. European countries fare significantly better. On this front, role models alone do not seem to be enough. Young women are prone to fear that the challenge of combining what is frequently a highly pressured and intense life as an academic scientist with the equally highly pressured and intense life of being a mother will be too much, even with a supportive partner. In the UK, Ottoline Leyser, one of the winners of the Rosalind Franklin Prize (a prize awarded by the Royal Society with funds from the Department for Business, Innovation and Skills; part of the application for this requires all nominees to put forward a proposal for a project that would raise the profile of women in STEM in their host institution and/or field of expertise in the UK) produced a wonderful booklet on 'Mothers in Science: 64 ways to have it all'¹¹. This booklet demonstrated the hugely varied career trajectories of 64 successful women in science, trying to dispel the myth not only that you can't combine motherhood and academia, but there is no single right way of successfully making the combination. Everyone is different, and their personal circumstances are different, but that doesn't add up to making the combination

¹⁰ http://www.iop.org/publications/iop/2006/file_42616.pdf

¹¹ <http://www.ias.ac.in/womeninscience/MothersinScience.pdf>

impossible. It does mean you have to find the solution that works for you and your family, and only you can work that out.

Work-life balance is different, more intangible, and again very personal. Overall, more than 60% of women with PhDs in science have husbands with PhDs in science whereas this figure is closer to 20% for males¹². This compounds the two career problem because of the difficulty of finding two compatible jobs in sufficiently close geographical proximity. When children enter the equation, statistically women are more likely to be the primary carer, or at least take the major share of responsibility for overseeing care, and hence their focus may shift. But, even without children, more women than men appear to be put off by the potentially all-consuming nature of an academic science career.

The Royal Society of Chemistry Report⁴ states:

'First, many women seem deterred by the all-consuming nature of scientific work, and the isolation it entails (particularly in the academic sector). Second, many women are daunted by a perceived incongruence between the characteristic of an academic chemistry career and motherhood.'

Some of these issues are beyond legislation or policy change because they are societal and cultural. Nevertheless, there are aspects that can be tackled, as the Institute of Physics Report¹⁰ states clearly:

'It is neither possible nor desirable to insist that academic and research staff work fixed hours. However, there are two important principles. First, one should not confuse long hours with productivity....Second... individuals should be judged on their output and not on their hours in the laboratory.'

This is echoed in an EU Report¹³ (not specifically dealing with academia) which writes:

'Offering work-life balance practices is not enough – the organisational culture (as evidenced in the communication about these practices, but especially in terms of

¹²) G Sonnert and G Holton, Gerald. 1995. *Gender differences in science careers*. Rutgers University Press.

¹³ http://ec.europa.eu/research/science-society/document_library/pdf_06/wist2_sustainable-careers-report_en.pdf

the behavior of supervisors and peers) must be truly supportive of the utilization of these policies. If the message is negative (“you will have to work extremely long hours and put in face-time in order to get promoted”), or mixed (“of course you can work from home, as long as I can expect you to come in at short notice”), many will not utilize what is on offer, and those who do, are likely to fear the consequences.’

The issue of how processes such as appointment, promotion, tenure should be carried out in the light of this will be discussed further below.

3.3 Isolation, lack of mentoring, confidence, role models and support networks

Let me turn now to the issues of isolation and the three items I identify as often lacking for women, those of mentoring, confidence and role models. All these issues recur in reports on obstacles for women. Confidence is one that is tricky since so many women can cover up their own feelings of insecurity beneath a confident exterior (as can many men of course). The so-called impostor syndrome – originally identified by Clance and Imes¹⁴ as describing people who internally do not believe in their success or convince themselves they deserve it, despite the outward signs of reaching very significant and visible intellectual milestones such as receiving higher degrees or professional awards – is probably very common. Cheryl Murray, now Dean of Harvard University’s School of Engineering and Applied Sciences and formerly for many years at Bell, where she rose to be senior vice-president for physical sciences and wireless research, has spoken of her inward lack of confidence which can hold her back when writing papers or making presentations. Despite her seniority she can say¹⁵

‘I can’t do this. I haven’t done enough experiments. I haven’t got enough data. I can’t write the paper well enough yet or give the talk.’

These fears one might naively expect to have been cast off by such a senior and respected researcher. A joint AIP/AAS survey of astronomy graduate students in the USA¹⁶ specifically examined the gender difference in the student's confidence and their internal self-belief. As Figure 3, taken from this study, shows women are much more prone to

¹⁴ P. Clance and S. Imes *Psychother. Theor. Res.* **15**, 241–247; 1978

¹⁵ Nature Vol **459** 21 May 2009 468

¹⁶ <http://www.aas.org/cswa/JAN10/Ivie20802.pdf>

doubt themselves and expect to be 'discovered' than men. This study, being carried out by Ivie and Aphrell at the AIP's Statistical Data Centre – a longitudinal one, so one can expect much richer data to be forthcoming – has also shown the importance of mentoring: students who are not mentored are less likely to feel welcome in their department, more likely to feel that they cannot succeed, and to feel that they are not as smart as their peers. These findings are probably equally applicable to other sub-disciplines of science beyond astronomy, and provide a clear indicator of both some of the internal issues for women and steps that may be taken to support the women before they give up on academia.

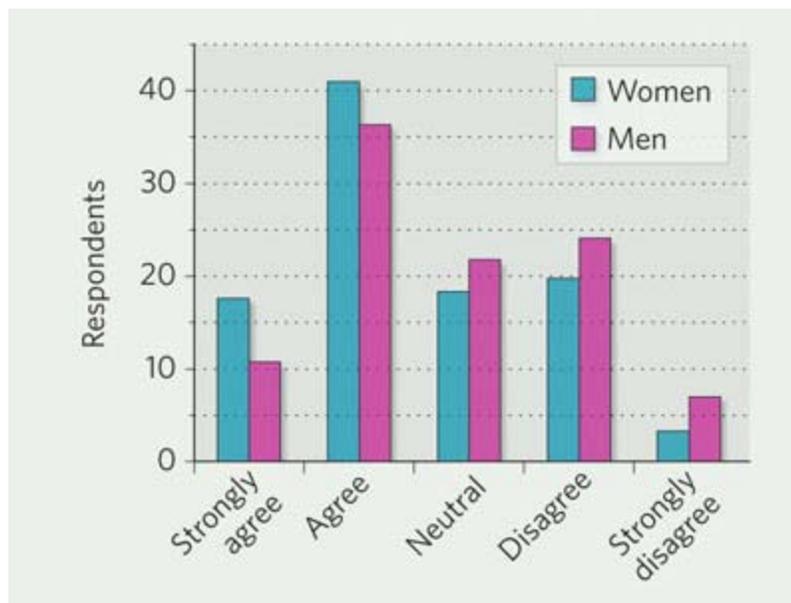


Figure 3 (from ¹⁵) The response of astronomy graduate students to the statement: “Sometimes I am afraid others will discover how much knowledge or ability I lack.”

Lack of role models is frequently cited as a concern for early career researchers, made more acute if they are also isolated in their workplace from other women. The evidence for this seems to be largely anecdotal, in that women (particularly young women) are often quoted as saying that role models can be influential (e.g. ¹⁷) rather than that there are

¹⁷ L Bonetta, Science Feb 12 2010, 889

many studies on this aspect (one limited study on trainees at a US Airforce Academy can be found at ¹⁸) . Recommendations from various high level bodies also often focus on this aspect (eg Recommendation 7 from the EU project Genset¹⁹ says 'women already within scientific organizations should be made more visible' because this 'allows for students and staff to see a number of possibilities in achievement and to choose from a variety of role models. Making women's work visible also encourages women already present in scientific institutions to reach higher positions.'). Likewise, the IOP recommends¹⁰ as good practice 'over a long period, it should be possible to ensure that at least 10% of the speakers are female. In departments with few or no female staff, it is particularly important to provide role models for the female postgraduates and RAs.' There can be no doubt that if you are a lone woman, only seeing men at the higher levels around you at the start of your career, not only do you feel very isolated in terms of day-to-day female chitchat, but you also may find it hard to imagine how you could progress. This is another context for which mentoring in some form may be very beneficial.

Self-help groups and support networks are of course something that women can arrange locally for themselves – as long as they can identify like-minded women elsewhere in the organization. There is no doubt that they can help to reduce the feeling of isolation, and provide a safe environment to vent frustrations and obtain advice from peers in dealing with sticky situations. One particular group has charted its discussions and pros and cons over many years in²⁰. Senior management can help to facilitate such networks, but very often they are best organized bottom up, since they will only work if the personal chemistry is right.

3.4 Unconscious bias and stereotyping

However it is items 8 and 9 on my list above – unconscious bias and stereotyping - where I believe most progress can be made, and this can be done on two fronts. Both by raising awareness amongst the senior ranks about internal schemata which can, in this context, be described as a structured cluster of pre-conceived ideas, and also by amending practice

¹⁸ <http://www.econ.ucdavis.edu/faculty/scarrell/gender.pdf>

¹⁹ http://www.genderinscience.org/downloads/genSET_Consensus_Report_Recommendations_for_Action_on_the_Gender_Dimension_in_Science.pdf

²⁰ E Daniell Every Other Thursday 2006 Yale University Press

around recruitment and promotion to help overcome stereotyping and preconception. The work of Valian²¹ and the Implicit Project²² with their Implicit Association Tests (IATs) demonstrate brilliantly how we all carry internal hypotheses about gender differences which in turn create small sex differences in characteristics, behaviours, perceptions, and evaluations of men and women. In turn these small differences can add up to major differences in recruitment and more general attitudes to men and women in different roles. For some people, when unconscious of the baggage they are carrying, the influences on decision making can be profound, and equally profound – but more devastating – for the people about whom decisions are being made. There can be invidious, but unconscious, differences in the way letters of reference are written²³. In²⁴ the authors note

'it is notable that recommenders used significantly more standout adjectives to describe male candidates as compared to female candidates, even though objective criteria showed no gender differences in qualifications. It is likely that evaluators place higher weight on letters that describe a candidate as the *most* gifted, *best* qualified, or a rising *star*. This could mean that even a small difference in the proportion of standout adjectives used in describing female candidates could translate into much larger evaluative effects.'

I find this chilling because I wonder how guilty we all are of this failing, until it is brought to our attention, and I think it is ubiquitous. For instance I noticed – and pointed out - in my own institution in the notes (written by a woman) for a promotion committee that the top-ranked candidate (a woman) sounded much less outstanding than the number two (male) on the list, despite the clear steer during the discussion of the excellence of the woman over the male. There is also evidence that when only a CV is presented, if two CV's identical in all but name (thereby disclosing gender) are examined, both male and female evaluators will score the male higher²⁵. These issues are more easily dealt with if everyone concerned in the assessments are aware of the potential pitfalls, and

²¹ V Valian *Why So Slow?* 1999, MIT Press

²² <http://www.projectimplicit.net/>

²³ JM Madera, MR Hebl and RC Martin *J Appl Psychol.* 2009 **94**,1591-9.

²⁴ T Schmader, J Whitehead and VH Wysocki *Sex Roles.* 2007 **57** 509–514

²⁵ RE Steinpreis,KA Anders, and D Ritzke *Sex Roles* 1999 **41**, 509-28

move towards transparent processes which make implicit assumptions less likely to linger.

3.5

Finally, I would like to comment on what happens as you move up the career ladder, a point brought out very forcibly in the MIT study⁹. What this study showed was that women who had said 'I also felt very positive when I was young', felt less and less valued as equals as they moved up to become full professors, to the extent that they could then say

'the heart of the problem is that equal talent and accomplishment are viewed as unequal when seen through the eyes of prejudice...there is a perception among many women faculty that there may be gender-related inequalities in distribution of space and other resources, salaries and distribution of awards and other forms of recognition. Currently, a glass ceiling exists with many departments....'

Or, as Meg Urry put it in the Washington Post article⁸,

'Over the years I saw women in the scientific world treated badly, being marginalized, mistreated, harassed. ...After years of being passed over, ignored and insulted, we start wondering what we are doing wrong. Maybe if I had made the suggestion differently, it would have been heard. Maybe if I lowered my voice and spoke more slowly, I would get more respect...'

That last comment is something I can relate to as it was a piece of advice I was specifically given by a senior colleague, to get voice training so that I was listened to more in meetings. And he was on my side! So, although the interventions I will go on to discuss are most likely to be useful for women starting out on the career ladder, perhaps in the 10 years post graduation, we should not forget the culture in many institutions is still inimical at all stages, and senior women have battles to win too.

4 Interventions

4.1 Monitoring?

So having identified the obstacles it is time to turn to (low cost) steps that can be taken to ameliorate them. I will deal with these at two levels, reflecting both my local experiences within my own university and through the Athena Forum at a national level. Because the

problems are so diverse, there is no 'one size fits all' solution, and there are many different paths that may reach equally satisfactory ends. However, I have become increasingly convinced that airing the issues in a factual way so that senior management can identify the way in which processes may be less than optimal – frequently for men and women -can actually have substantial effects in very cost-effective ways. In terms of support networks and informal mentoring, it goes without saying that these can be organized in simple and unofficial ways locally. What I am interested in is more formal processes.

Within the UK, legislation (the Combined Equalities Scheme) is on our side in that higher education institutes are expected to produce Equal Pay Reviews, and this can highlight any significant discrepancies, both in the numbers of women at different grades (why are there fewer female professors? being the sort of question such an analysis will reveal), and where the average pay is significantly different (why are all the female lecturers towards the bottom of their pay scale?). Legislation assists because it removes the 'stigma' attached to a group of women apparently complaining about unfairness. Any monitoring is valuable, because it provides hard facts, and all organizations' best practice requires this in many situations. Sometimes this monitoring needs to be done at the university level, as with pay comparisons, but sometimes disaggregating is either helpful or crucial. For instance, if you want to know if more female students are dropping out of a course than males at the end of the first year, only carrying out the analysis at the level of the course (which may or may not tally with a department) is useful.

The UK has a system of recognition, known as the Athena Swan Charter awards, which operate as recognition of good practice at both the university and departmental level²⁶. These awards, which have been running since 2005 in their current form, have very much become a prompt to provide something for science departments to aim at. The six principles which Charter members are asked to accept and to incorporate into their action plans are:

²⁶ <http://www.athenaswan.org.uk/html/athena-swan/>

1. *To address gender inequalities requires commitment and action from everyone, at all levels of the organisation*
2. *To tackle the unequal representation of women in science requires changing cultures and attitudes across the organisation*
3. *The absence of diversity at management and policy-making levels has broad implications which the organisation will examine*
4. *The high loss rate of women in science is an urgent concern which the organisation will address*
5. *The system of short-term contracts has particularly negative consequences for the retention and progression of women in science, which the organisation recognises*
6. *There are both personal and structural obstacles to women making the transition from PhD into a sustainable academic career in science, which require the active consideration of the organisation.*

In seeking to become a member of the Swan Charter, first a university must submit an application as a whole, to demonstrate the organisation's commitment to these principles and, assuming this is successful at (at least) the bronze level thereafter individual departments can make their own application for bronze, silver and gold awards. Some universities have multiple departments achieving silver awards, others have none. But, increasingly, recognition is seen by the community as a benchmark and something to aspire to. In my own university, the Physics department has just received a Silver award. We are hoping that we can now extract from our successful application a basic template that other departments can adopt and amend to fit their own circumstances.

4.2 Institutional Self-Scrutiny

What really matters is of course the thinking that underpins the application, the self-scrutiny that a department (or university) must go through in order to put together a successful proposal. Monitoring is a key part of this, examining the numbers of women at each stage of the pipeline, whether they are on comparable terms (eg are there more women than men on fixed term contracts?), and where women are being lost or stuck at some bottleneck along the pipeline. Based on this, an appropriate action plan can be put

together to try to overcome identified problems. There are many relevant issues beyond simple statistics which this self-assessment may tease out, and many types of good practice a department/institution might already be pursuing or could readily adopt. Here I will just highlight a few: exit questionnaires, to establish why people are leaving; timing of research seminars to be sure they are family-friendly; consideration of flexible working patterns; support networks and mentoring; inclusive staff meetings; discussion forums, possibly different ones for people at different stages, to identify concerns and propose actions and/or staff satisfaction questionnaires; and (a hugely important issue) transparency of processes around recruitment and promotion, which I will discuss in more detail below. Many of these initiatives do not cost much in explicit cash, although some may be quite time consuming for key people in an organization, but the impact on the working culture can be extremely beneficial.

There are different ways of establishing how the workforce feels about working conditions, but questionnaires (anonymous) are often useful if numbers are large enough for anonymity to be preserved and statistics to be meaningful. Within the UK a useful tool has been the national ASSET (Athena Survey of Science, Engineering and Technology) survey²⁷ carried out every few years. There is a good practice guide associated with this at their website, which identifies helpful approaches and ways to use the institution's disaggregated responses. Because the survey is for men and women and carried out at regular intervals it is particularly illuminating about differences for the sexes, and how these may be changing over time.

4.3 Policies and Processes

Of course, as I indicated above, the key to success is buy-in from senior leaders, the will to effect change and to explore processes. If policies are good and implementation is not, then the culture will not change. This seems to be a formidable obstacle in some ways, as culture is deeply ingrained and can be so much taken for granted it becomes invisible. But having senior staff asking, loudly, awkward questions has to be progress; having someone explicitly given the authority to do this must also contribute to modifying the

²⁷ <http://www.athenasurvey.org.uk/universities.htm>

environment. Thus, if an equal pay review is carried out, what happens next is a key question. Who looks at the outcomes and decides on actions to remedy any failings found? My university has set up an appropriate committee to analyse the underlying issues to see what the statistics actually mean. Time will tell whether it leads to genuine improvements, but it was interesting to watch the University Council come to the conclusion that statistics alone were not enough and that an ongoing committee had to be constructed, having initially set up a working group that was wound up after less than a year as having 'dealt' with the issues. Culture change is a long term process. It is clear that simply having a sympathetic head of department, for instance, is not enough because once their term comes to an end nothing may have changed at a fundamental level.

So, institutionally, processes must be adopted – and followed – that enshrine good practice. The three key topics that I would identify as needing to be scrutinized are recruitment, promotion, and mentoring and training, since these will colour the make-up of the workforce and their progression. Some questions a typical organization should ask itself are:

a) Recruitment

- Is recruitment passive, or are positive steps taken by the search committee to identify potential candidates, including women, to ensure there is a diverse pool? Too often no steps are taken to attract strong candidates who aren't within a clique, which may be all male.
- Are steps taken to make the position attractive in the advertisement e.g describing family friendly policies?
- What positive steps are taken by the university to assist dual career couples move together e.g by helping the partner identify appropriate local opportunities?
- Is the membership of the appointment committees suitably diverse?
- Are appointment committees trained to be sensitive to equality issues?

b) Promotion

- Who advises potential applicants whether or not to apply, and is this mechanism

appropriate?

- What steps are taken to prepare potential applicants in the run-up to a promotion application?
- Are women applying at comparable times in their progression, or are they being discouraged to apply till a later stage than men?
- Are promotion criteria explicitly written down and adhered to?
- What is the weighting given to the different types of activity (e.g. teaching, research, pastoral, administration)? It is apparent that women are often not offered the opportunity to take on the roles that promotion panels value, but may be encouraged to take on 'softer' tasks such as student welfare or admissions. This propensity needs to be monitored.
- Is there mentoring at an early stage to ensure the potential applicant gains the skills that the criteria require?
- Is the gender distribution of panels appropriate?
- How are career breaks or part-time working handled in promotion criteria and applications?
- What allowance is made for constraints on e.g travel to give high profile lectures due to caring responsibilities? For instance, is it permissible to list invitations even if declined?
- As above, are promotion committees trained to be sensitive to equality issues?
- Are application and success rates monitored for men and women?
- What feedback is provided for unsuccessful applications?

c) Mentoring and Training

Mentoring needs to start at an early stage in a research career, and as often as not is informal; this has always been the way and formal systems are more recent. The need for formal mentoring arises because it is too easy for the 'less-well connected' who may be minorities of different sorts including women, may slip through the informal net. So the questions that need to be addressed here are:

- Is formal mentoring provided?
- How are the mentors selected and are they trained themselves in mentoring?

- Is there a staff review process and, if so, how are the outcomes reported including to both mentor and mentee, but also to senior management?
- What statistical information is gathered from such a review process to check if people are benefitting equally?
- How are training needs identified, and what programmes are on offer?
- What advice is given about which tasks and responsibilities it is reasonable or wise to take on? This is relevant to the point raised above in 2.
- Is there a transparent workload model to ensure chores are shared out reasonably around a department?

Most of these questions under all these headings can be answered rather straightforwardly if there is a will to do so. These do not in themselves require substantial investment in funds, so much as time and thought.

Finally, there are a few other steps a department can usefully take to increase the visibility of women. Two notable examples are ensuring departmental seminars include female speakers regularly, and that – if there are newsletters or websites - the success of women is duly celebrated. This does of course require the women concerned to 'blow their own trumpets' which not all are comfortable doing, but here again mentors may be of assistance in blowing the trumpets for them when grants are awarded, for example, or prizes won.

4.4 Actions at the National Level

Let me turn now to productive activities at the national level, where an appropriate organization made up of senior scientists (not necessarily themselves women, although in the Athena Forum a substantial number of us are) may be able to influence change. The Athena Forum comprises an independent chair and deputy chair – currently I am the chair – together with senior representatives from key professional bodies and learned societies. Having these representatives as our members means that they can act as appropriate intermediaries into the professional bodies, and thereby help to disseminate best practice. Our initiatives so far have included questionnaires to both the professional bodies and the

main research funders within the UK. Based on each set of responses, we produce combined summaries of what we deem to be best practice²⁸. Different organizations have established different internal patterns of working, different routes to support women, and gathered different sets of statistical and anecdotal information. By bringing together the various ideas we can see what is working and what is likely to be most beneficial for influencing change in the future. By disseminating this information we hope to be able to save each grouping reinventing a well-established wheel, but also perhaps embarrassing some organizations into trying harder and to be more reflective when their practices are less than optimum. For instance, when we carried out our survey we were very impressed by the London Mathematical Society Council's statement on the position of women in Mathematics²⁹, which explicitly recognizes the issues within mathematics where the numbers of women are particularly low. That this is a statement from the LMS's Council makes it even more significant – as with universities, change will only happen if there is a will at the highest levels, and so the endorsement of the ruling Council is a vital help. The Athena Forum is still putting together its latest report based on the policies of the major research funders, following a discussion meeting with key representatives this summer. But what was encouraging was the engagement of the funders and their enthusiasm to enter into dialogue about key problematical issues, such as maternity leave on grants and the need to ensure they – like universities – carry out due monitoring around application and success rates.

5 What makes a woman successful in science?

If all these recommendations were put into practice, would we immediately see a substantial increase in the numbers of women reaching the higher echelons of science? It would be nice to think so, and I believe the answer is potentially yes. But there are many aspects which are sufficiently intangible that I don't believe things are likely to be transformed rapidly if ever. I have already mentioned the issue of work-life balance. If women in large numbers are to stay in science there are societal issues way beyond anything covered here which may need to change: I have already mentioned the issue of

²⁸ http://www.athenaforum.org.uk/reports/Report1AthenaForumGPGforSTEMM_styled.pdf

²⁹ http://www.lms.ac.uk/policy/wim_statement.pdf

maternity leave but the question of paternity leave is equally pertinent. Childbirth itself is not something that can be shared equally, but much of childcare can be (and the same is true of caring for other family members). Still it is frequently seen as the mother's responsibility, which necessarily puts her at a disadvantage, and sorting out school holiday cover - or being the emergency cover in case of sudden illness and days off school - will, by default, be seen as the mother's problem for the vast majority of families. Changing that societal pattern would make a significant difference, but there is nothing specific there for women in science.

Secondly, the way universities currently operate means that there is an implicit long hours culture, which is not attractive to some women (and indeed men too), and which deters them from trying to reach the top of their professional tree, even for those without significant caring responsibilities. So, some may choose not to seek promotion but choose a lifestyle which suits them better with less pressure. For these women, they may contentedly settle for a position which to others might look like comparative failure. This is not a glass ceiling in the normal meaning of the phrase but a conscious choice. However, there are other women who feel they constantly strive to progress yet equally constantly are knocked back. The comments of Meg Urry's I quoted earlier represent the sort of daily obstacles which can add up to a tally that feels unsurmountable. When I am asked what has contributed to my success, aside from an immensely supportive husband the other key factor is a degree of bloody-mindedness; it takes resilience and determination to keep going when the odds seem stacked against you. And yet so many of these knocks are completely unconsciously delivered. The recognition that you are not alone in feeling like this, can be very beneficial: that it is not that you are being singled out for this sort of treatment personally, but it happens to everyone. I remember being very struck by a comment made to me by a junior colleague once who said ' you mean you had problems too!'. Being successful does not mean that nothing bad ever happened on the way up the ladder, but it also is proof that bad things need not necessarily be terminal. That is where networking helps and removes the sense of isolation and the feeling that it must be your own fault when things go awry and you feel patronised or overlooked.

6 Conclusions

This is a problem that is not going to go away. The economic argument for keeping women who enter the science pipeline in the subject seems to have been won, so it is now a question of finding strategies that work. There is no simple panacea, not least because each discipline and each country will have its own particular culture and expectations which need to be addressed. Nevertheless it is clear that some relatively simple actions, with monitoring at their heart and necessarily with buy-in from the top of the organisation, can start to make a difference. It will not be a speedy transition, because it will be many years before the young women entering science degree courses now are transformed into the professors of tomorrow. Progress has been steady but slow, and I suspect that that is how it will continue. But with explicit discrimination largely a thing of the past, and more of the unconscious discrimination being revealed and recognized, we must hope that the inexorable rise in numbers will continue.