Written Evidence submitted by Professor Dame Athene Donald, DBE FRS
(DIV0008)

Executive Summary

Athene Donald, DBE FRS is Master of Churchill College, Cambridge, and professor emerita of Experimental Physics at the University of Cambridge. I was the University's first Gender Equality Champion (2010-14) and have served on numerous committees involved with issues around women in STEM, including the BEIS diversity committee set up by David Willetts when Science Minister, as well as within the Royal Society and the Institute of Physics. I chaired the Athena Forum for several years and was recently a member of the Athena Swan Assessment Review Group, which reported in 2020. I have written extensively on the topic of women in STEM, in pamphlets (eg for the John Smith Institute), in mainstream media and on my own blog, and been interviewed numerous times on various radio and TV channels. I am contracted to write a book on the subject for Oxford University Press, which is currently with the editor and due for publication next year.

Preamble

I will mainly focus here on issues associated with gender in this submission, with which I am most familiar. Due to my sphere of activity, I will also primarily focus on education, including academic science. Many of the same hurdles that women face are equally faced by ethnic minorities, but the data has been accumulating longer in the case of gender. Where I believe there are similarities between these groups, I will make this clear.

It starts at birth

1. Issues and actions which subsequently impact on children's choices regarding careers start essentially at birth. Recent evidence indicates that there are essentially no significant differences between the brains of male and female babies at birth[1].
2. Brains are very plastic – they can form and destroy new neural connections at a huge rate, particularly in early life – and so will be directly moulded by their environment and experience. This will include the way carers and others interact with a growing child.
3. Stereotyped behaviour directed towards a child will tend to lead to that child developing those stereotypical responses. A parent or teacher who says 'girls can't do maths' will be providing a message that children internalise; a peer who sneers at a girl building with Meccano will cause the child to question their choices. These actions are not neutral; the implicit expectations will be imbibed and are likely to be material to decisions a child makes about what is 'appropriate' for them to continue to do in later years.

[1] *The Gendered Brain* Gina Rippon Bodley Head 2019

4. Research[2] in the US showed that, as early as 6-7 years old, children start making gendered decisions about what are suitable toys for them to play with, with girls identifying that certain games are for the 'really, really smart' – which to them already mainly means boys – whereas at 5 years old, that distinction was not made. Since subjects such as physics (and economics) are those which later on are associated with 'brilliance', the equivalent of the childish phrase 'really, really smart', this study highlights how early children pigeonhole different sorts of activities by gender.
5. As children move on to make decisions about post-16 choices and careers, these internal messages will play a crucial part. At this stage, role models can play an enormous part in countering early stereotyping. This will apply to girls, who need to see examples of scientists who are not just white and male, but equally to racialised minorities, for whom it is at least as important to see people like them. Seeing could mean literally in the classroom, on posters or in textbooks. In practice, as The American Chemical Society showed in a study[3] demonstrating the paucity of references and images of women in standard texts used in early chemistry courses, this does not happen. There is no reason to believe the situation is different in STEM subjects other than Chemistry, or for ethnic minorities.
6. The influences on choices comes from right across society, not least the media, but teachers obviously play a key role. The Institute of Physics (IOP) has been studying how classroom behaviour impacts on outcomes for many years with respect to girls and physics, and has published a series of reports on the subject. They have piloted various interventions, most notably how attitudes across the school have a direct impact (much of their work over decades is summarised here[4]).
7. One striking finding from the IOP was the impact of single sex schooling on the progression of girls to Physics A Levels. Students in girls-only schools were approximately twice as likely to progress to A Level as those in co-ed schools (whether these were state or private schools)[5], negating any thought that girls are absent simply because 'they don't like Physics'. It was subsequently shown[6] that there was equivalent detriment to boys moving into 'girls'' subjects, such as Psychology and English. These problems cut both ways.

Not all STEM subjects are equivalent

8. At A level, the proportion of girls studying the different sciences varies widely, with a majority in subjects like Biology and Psychology, and only around 20-25% in Physics (a necessary precursor to an Engineering degree).
9. This feeds into the proportion of women studying different degree courses: around 80% of the Veterinary Medicine students in Cambridge are female, but around 80% of the Physics students are male. Both proportions are equally a problem for diversity in the STEM workforce. Numbers are approximately equal in Chemistry at undergraduate Level across the country. Computer Science courses, however, have become increasingly male-

[2] https://www.science.org/doi/10.1126/science.aah6524
[3] https://pubs.acs.org/doi/abs/10.1021/acs.jchemed.0c01037?source=cen&
[4] https://www.iop.org/sites/default/files/2019-07/IGB-reflections-intervention.pdf
[5] https://www.iop.org/sites/default/files/2019-04/its-different-for-girls.pdf
[6] https://www.iop.org/sites/default/files/2019-03/closing-doors.pdf

dominated over the years: computing used to be seen as a female subject in its early days, but no longer. Engineering has always been male-dominated. In most universities, Mathematics has an approximately even distribution, although the percentage of girls who take Further Mathematics at A Level is significantly less than 50% with consequences for the more quantitative courses at university.

10. These uneven numbers are a direct reflection of messages received earlier in life by potential students.

University

11. A student's experience on their course may vary enormously depending on circumstances, but anyone in a minority is likely to feel particular pressures simply due to being 'different'. This will apply to any sort of minority (even a white male on a Veterinary Medicine course). Awareness of these potential challenges amongst those teaching is imperative, and they mustn't simply sweep such issues under the carpet.
12. The potential for 'stereotype threat' to reduce performance was first identified by Claude Steele in the context of black students on Mathematics courses in the US (see [7]). It can apply to any minority in a specific subject. In this phenomenon, awareness of expectations e.g. of poor performance in a maths test for blacks or women, can cause sufficient cognitive discomfort and distraction that the awareness becomes a self-fulfilling prophesy. Minor interventions – for instance self-affirmation (see [8] for a recent example) or not being required to pay attention to your gender/ethnicity when filling in your identity (see e.g. [9]) – have been shown to have a surprisingly large effect in some students in courses such as Physics, mostly conducted in the US.

Academic Careers

13. During the early years of a researcher there is a need for mentoring and exposure to different laboratory environments and cultures as well as aspects of project management, if they are to develop confidence and skills. Such opportunities are not as often available as they should be but, when they are, will particularly make a difference to those who feel insecure due to difference.
14. The use of short-term contracts, leading to insecurity and precarity of employment which can particularly impact and push out women of child-bearing age, need to be reconsidered. This needs a radical rethink of much of the funding landscape, including the use of QR, FEC costing and the length of individual awarded grants. It cannot be done by institutions alone.
15. The leaky pipeline is a phrase often used to describe how the low numbers of women on some courses translate into even lower numbers as one moves up the academic ladder. Although the number of women starting in a given subject varies, in every subject the proportion decreases; the rate of decrease is subject-specific. Whereas Chemistry starts off

[7] *Whistling Vivaldi* Claude Steele 2011 WW Norton and Company

[8] https://journals.aps.org/prper/pdf/10.1103/PhysRevPhysEducRes.17.020121

[9] https://arxiv.org/abs/2007.02311

with approximately equal numbers of men and women, by professorial level the proportion of women is little different from Physics, which started from a much lower base. Numbers start much higher in Biology, but end up little better. There are systematic disadvantages for minorities which, by now, are quite well understood, but insufficient has been done to eradicate them.

16. These disadvantages can often be grouped as arising, at least in part, from unconscious bias, but there are many different manifestations on the academic path, and insufficient change in practice and behaviour has yet come into play.
17. Different arenas in which disadvantage plays out arise in i) letters of reference[10]; ii) refereeing of job applications and publications[11] [12]; iii) informal networks and the opportunities these offer to access jobs or senior roles; iv) application of double standards in assessing candidates, where women are frequently judged on achievements but men on potential; v) timing of calls for funding, where short notice calls timed in school holidays, for instance, may eliminate carers; additionally women and minorities are seen as less strong candidates to lead large grants; vi) implicit and external criteria used in promotion and progression.
18. These systemic disadvantages sit on top of any harassment, bullying or overt discrimination that may occur at any level. There is no doubt that bad behaviour directed against women and ethnic minorities is still sadly too often present. Universities (and individual departments) are often not well-equipped to deal with such situations, which may arise most painfully when there is a power imbalance between perpetrator and victim, but can also be pernicious when peer-on-peer interactions go wrong.
19. Issues of sexual and racial harassment on university campuses have been too frequently in the news, but still processes for handling these matters and appropriately dealing with perpetrators are often inadequate. The use of NDAs permitting an offender in these matters to move institution without disclosure needs to be stopped.
20. The R&D People and Culture White Paper set out some laudable goals, but any requisite levers to ensure desired improvement in research practice were barely mentioned.
21. Publications form a crucial part of an academic's life and may be impacted by bias at each stage. Bias will not be eradicated merely by diversifying editorial boards and choice of referees[13]. A 2019 report from the Royal Society of Chemistry's[14] regarding their own editorial and publication processes stated *'Biases exist at each step of the publishing profile. Many of these biases appear minor in isolation, yet their combined effect puts women at a significant disadvantage*.' It seems probable these problems beset publication by minority ethnics too. Any imbalance in ability to publish will have direct consequences on career prospects and may drive talented researchers out of STEM completely.
22. Blinding of either CVs or publication authors can be challenging. The higher up the academic ladder one travels the fewer the number of laboratories (for instance) that could be producing a particular type of work, meaning anonymity is hard to maintain. Some journals –

[10] https://www.science.org/content/article/recommendation-letters-reflect-gender-bias
[11] https://www.pnas.org/content/109/41/16474
[12] https://www.pnas.org/content/109/41/16474
[13] https://www.timeshighereducation.com/opinion/academic-publishing-must-do-better-gender
[14] https://www.rsc.org/globalassets/04-campaigning-outreach/campaigning/gender-bias/gender-bias-report-final.pdf

notably the Nature family – have experimented with different ways of blinding, but with limited success[15].

23. Criteria for promotion and progression often contain additional implicit hurdles. One example would be the expectation of presenting international talks. Pre-pandemic, carers would have been much less likely to travel even if they received such invitations. Absence of attendance at such conferences was often implicitly translated as lack of international standing.
24. Citations might appear to be an objective metric to assess the importance of a piece of work, but in practice is affected by gender bias, with women's work being less cited[16].
25. Evidence shows that women[17] (and minorities) end up doing more of the 'chores', taking them away from high profile research. There is strong evidence that women are more likely to end up doing pastoral care, outreach, office teaching hours and general administrative tasks than men. Unless criteria for progression explicitly score such activities with appropriate weight to the value apparently attached, this will only disadvantage those who are good citizens (see recommendations from the Russell Group[18]).
26. As in many other spheres, informal networks play a subtle and sometimes invisible part in who knows about what opportunities and how decisions are taken. Individuals – typically minorities – who are not tapped on the shoulder with invitations of different kinds will have weaker CVs.
27. Similar issues surround funding, notably judgements being made over CVs and publications, as part of decision-making over grants. Gendered double standards over the potential of a proposed piece of work as opposed to demonstratable viability may also be present during evaluation. All those biases need to be carefully considered, and it is noticeable funders are beginning to pay attention to these aspects.
28. Nevertheless, recently gathered statistics still show that women and ethnic minorities are not funded to the same level as white males, particularly for large grants; there is work to be done in removing biases, wherever they may appear in the system.
29. Additional hurdles that funders sometimes inadvertently introduce relate to the timing of calls. When short notice calls are timed during the school holidays, or even half term, there may be a direct impact on carers who are unable to.
30. The Athena Swan process has been effective in STEM departments but has become overly bureaucratic. The recommendations of the Review Group I was involved with, for streamlining to reduce bureaucracy, were only partially followed. Beyond gender, other accreditation marks (e.g. the Race Equality Charter Mark) should be similarly developed as light touch. It may not prove workable to amalgamate all into one scheme, since the needs of and solutions for each diversity strand may be radically different.

Recommendations

Early and School Years

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[15] https://researchintegrityjournal.biomedcentral.com/articles/10.1186/s41073-018-0049-z

[16] https://www.researchgate.net/publication/220434624_Are_Female_Researchers_Less_Cited_A_Large-Scale_Study_of_Norwegian_Scientists

[17] https://www.tandfonline.com/doi/full/10.1080/1360080X.2019.1589682

[18] https://russellgroup.ac.uk/media/5924/rce-toolkit-final-compressed.pdf

- Interventions need to start early in life; waiting until decisions are taken around the time of GCSEs or equivalent is too late. Teachers at all stages need to be trained to be sensitive to the impact of unconscious bias and how it affects their behaviour in the classroom; examples of non-white, non-male scientists should be made accessible to all children from the earliest years. BEIS and DfE need to work closely together to overcome some of the barriers in the classroom with an eye to future workers in STEM.
- CPD of teachers to ensure they are expert in recognizing their own biases, and have tools to counter them, should be facilitated. School lessons should enable a variety of real-life role models to be brought into the classroom (female scientists, black engineers…..) and both curricula and individual lessons need to move far beyond the scientist as middle-class, white and male.
- Both work experience/placements and careers advice must steer well clear of simply utilising outdated stereotypes to inform advice and decisions. Work experience should also ensure that children whose parents lack easy contacts for providing placements still get appropriate and wide-ranging opportunities.
- The whole school, at both primary and secondary, should work together to embed diversity in thinking in all parts of the curriculum, to the benefit of all students.
- Routes other than A Level to University, such as BTECs, should be sustained. The opportunities offered by T Levels will only materialise if industry is able to provide the placements, which currently they do not seem able to. The streamlining of courses at FE is essential if these routes are going to be most effective.

University and Beyond

- Following on from the above, appropriate courses at FE should be available for adult returners looking to upskill in STEM, with appropriate funding provided (not simply loans, which may act as a deterrent).
- Accreditation marks such as Athena Swan should continue to be used to effect change in departmental environments, but should be kept as light touch as possible.
- For students from less advantaged (defined broadly) backgrounds who are interested in pursuing science beyond undergraduate studies, in industry or academia, funds should be established to permit those otherwise unable to gain experience in a laboratory (e.g. over the summer vacation) to build their CVs.
- PhD students and early career researchers should be offered formal mentoring and opportunities to gain experience beyond their own research groups, including in leadership and project management.
- Universities must broaden their appointment/promotion criteria at every rung of the academic ladder and eradicate bias and inappropriate behaviour throughout the institution, Good citizenry (beyond obtaining research funding) should be required and valued. Funders have a role in ensuring that long-standing habits and perverse incentives are shaken up.
- Publishers and editors, conference and committee organisers and other parts of the academic ecosystem must each play their part in removing barriers absolutely explicitly,

including spelling out their actions directed towards improving diversity, being held to account on these and increasing transparency in all their processes.

- Funders and institutions should explicitly use a ‘basket of metrics’ to evaluate candidates, so that good citizenry, including mentoring and pastoral care, is appropriately recognized.
- All organisations should ensure wide-ranging monitoring of success rates (for grants, promotions etc) and set KPIs to track progress towards a level playing field.
- A radical rethink of funding streams may be required to ensure that ‘white male as default’ are not in any sense favoured by processes, and that there are means to ensure precarity for early career researchers is reduced.

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