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Women in science

NZAS Awards 2014

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A forum for the exchange of views on science and science policy.

Editor: Allen Petrey
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Contents

Cover: Michelle Dickinson receives the NZAS Science Communicator Award from the Minister of Science and Innovation, Hon Steven Joyce, at the Association's awards function at the Royal Society of New Zealand, 11 Turnbull Street, Wellington, November 2014.

Instructions to Authors

New Zealand Science Review provides a forum for the discussion of science policy. It also covers science education, science planning, and freedom of information. It is aimed at scientists, decision makers, and the interested public. Readability and absence of jargon are essential.

Manuscripts on the above topics are welcome, and should be emailed to the editor (editor@scientists.org.nz).

As well as full papers, short contributions, reports on new developments and conferences, and reviews of books, all in the general areas of interest detailed above, are invited. The journal may also accept reviews of a general nature and research reports.

Full manuscripts (with author's name removed) will be sent for peer review, and authors will be sent copies of the reviewer's comments and a decision on publication. Manuscripts should not normally have appeared in print elsewhere, but already published results discussed in the different, special context of the journal will be considered.

Manuscripts should be accompanied by biographies of not more than 100 words on each author's personal history and current interests. Authors are also expected to supply a suitable high-definition passport-size photograph of themselves. This will be published with the article.

Articles may be submitted in MS Office Word, rich text format, or plain text. Diagrams and photographs should be on separate files (preferably eps, tif, jpg, at 300 dpi), not embedded in the text.

All tables and illustrations should be numbered separately – Tables 1, 2, 3, 4, etc., and Figures 1, 2, 3, 4, etc. – and be referred to in the text. Footnotes should be eliminated as far as possible. Diagrams and photographs will be printed in black and white, so symbols should be readily distinguishable without colour, and hatching should be used rather than block shading. However, colour may be used if the author or the author's institute is willing to pay for the added cost.

References should preferably be cited by the author–date (Harvard) system as described in the Lincoln University Press *Write Edit Print: Style Manual for Aotearoa New Zealand* (1997), which is also used as the standard for other editorial conventions. This system entails citing each author's surname and the year of publication in the text and an alphabetical listing of all authors cited at the end. Alternative systems may be acceptable provided that they are used accurately and consistently.

In this issue

We have four papers from this year's New Zealand Association for Women in the Sciences annual conference in this issue of the *New Zealand Science Review* and an invited paper written subsequently to the conference. All deal with aspects of women's participation in the sciences.

The guest editorial by Emma Timewell, Priscilla Wehi and Esther Haines points out that barriers to women's full participation in science, technology, engineering and maths (STEM) fall into three groups.

The first consists of structural issues such as the long training period and the insecurity of early career posts in STEM. The second includes pragmatic issues such as taking time out to care for children or other family members, and managing dual careers. Finally, cultural issues such as unconscious bias and family expectations also act as a significant barrier to the full participation of women in the sciences.

Frankly it is astounding that in the twenty first century such issues continue to present barriers to a woman's career in the sciences. There is simply no justification for this. As pointed out by Nicola Gaston[1], the principles of science deserve to be followed without pride or prejudice.

Finally in this issue we report on the NZAS annual awards – the Marsden Medal for a lifetime of outstanding service to the cause or profession of science, the Shorland Medal for recognition of major and continued contributions to basic or applied research, the Research Medal for outstanding fundamental or applied research by a scientist under the age of 40, and the Science Communicator Award. To each winner of this year's awards we say congratulations.

Allen Petrey
Editor

The converging roles of men and women are among the grandest advances in society and the economy in the last century. These aspects of the grand gender convergence are figurative chapters in a history of gender roles. But what must the 'last' chapter contain for there to be equality in the labor market? The answer may come as a surprise. The solution does not (necessarily) have to involve government intervention and it need not make men more responsible in the home (although that wouldn't hurt). But it must involve changes in the labor market, in particular how jobs are structured and remunerated to enhance temporal flexibility ...[2]

[1] Gaston, Nicola. 2014. Pride and prejudice: Why science is sexist. *New Zealand Science Review 71(3)*: 70–74.

[2] Goldin, Claudia. 2014. A grand gender convergence: Its last chapter. *American Economic Review 104(4)*: 1091–1119.

Guest editorial

ASSOCIATION FOR WOMEN IN THE SCIENCES CONFERENCE 2014

Absolutely Positively Science

The eighth Association for Women in the Sciences (AWIS) conference was held in Wellington in July. Around 150 attendees gathered over the two-day event to share experiences and inspiration. Some of their stories are included in this publication, and we would particularly like to thank Nicola Gaston for her tireless efforts in bringing the papers in this issue to fruition.

The barriers to women's full participation in science, technology, engineering and maths (STEM) fall into three groups. First, structural issues such as the long training period and the insecurity of early career posts in STEM can conflict with women's aspirations. Secondly, pragmatic issues such as taking time out to care for children or other family members, and managing dual careers, are also important. Finally, cultural issues such as unconscious bias and family expectations can also act as a significant barrier to the full participation of women and other groups. These factors are not independent: they interweave and feed back on each other. Effective action to identify and remove these barriers requires a systemic approach such as those championed by the National Science Foundation ADVANCE Awards in the USA or the Athena SWAN Charter in the UK*.

AWIS' key driver is to create an environment where women and girls with an interest in science can gain confidence and develop their scientific abilities. Networking is a key part of this, and the triennial conference is a unique event specifically designed for this purpose. It brings together women from across the science system – including secondary and tertiary students, researchers from universities, Crown research nnstitutes and private enterprise, and policy-makers – to share ideas and learn from each other.

AWIS, as an organisation, is constantly evolving to meet the requirements of the New Zealand population. There is still imbalance in the science system, not just an inequality in pay but also in the number of women, particularly in senior positions. It is imperative that all aspects of the science system have balanced representation, encouraging a mix of ideas, backgrounds and skills that can best address the needs of our nation and the world. It is by building connections, through events such as the AWIS conference, that we can provide encouragement and mentorship for women, as they enter and move through the science workforce, to support them on their journey and ensure they reach their full potential.

At this year's conference, we saw Judith O'Brien from the University of Auckland officially receive the first Dame Miriam Dell Award for Excellence in Science Mentorship. This Award will be offered again in 2015, and is just one way that we can acknowledge those that go the extra mile to support women in science.

AWIS has also introduced corporate membership, to broaden the audience who can access information and events offered by the Association. We congratulate and thank our first corporate members – the Faculty of Science at the University of Auckland, Plant & Food Research, Unitec, MetService, and Landcare Research – for having the foresight to support their female staff in this manner. We hope many more organisations will join us over the coming years.

AWIS has come a long way since the its inception in 1985, but still has a part to play in ensuring New Zealand science thrives. The articles in this special issue exemplify this, and discuss a wide range of issues that are relevant to women. Judith O'Brien focuses on the critical role of mentoring in developing a science career, particularly if your career path does not fit the norm. Elissa Cameron, Angela White and Meeghan Gray show how an apparently objective measure of performance can be biased against women. Gina Grimshaw describes how research on the brain can be misrepresented to bolster unconscious beliefs, while Nicola Gaston takes an overview of some of the implicit barriers for women. Cather Simpson describes how the Department of Chemistry at Case Western Reserve University was transformed through a National Science Foundation ADVANCE project that addressed both cultural issues such as implicit bias and pragmatic issues such as paid parental leave and partner hiring policies.

We in AWIS look forward to the challenges of the future and will continue to showcase the important role of women in science in New Zealand.

Emma Timewell
AWIS National Convenor 2014

Priscilla Wehi
AWIS Conference Chair 2014

Esther Haines
AWIS National Convenor 2012–14

* Information about the NSF's ADVANCE programme can be found at the website: http://www.nsf.gov/crssprgm/advance/ and other links from there, while information about the Equality Challenge Unit's Athena SWAN programme is at http://www.ecu.ac.uk/equality-charter-marks/athena-swan/about-athena-swan/

The Miriam Dell Award

In 2013, the Association for Women in the Sciences (AWIS) launched the Miriam Dell Award for Excellence in Science Mentoring, a biennial prize awarded to someone who demonstrates outstanding mentoring efforts to retain females in science, mathematics or technology.

The recipient of the Miriam Dell Award may be related to any part of the science system, for example teachers at primary or secondary schools, lecturers or supervisors in tertiary education, or in the science workplace. Mentees may also be at any stage in the science system – from school age to the science workforce.

The recipient of the Award will receive a glass trophy and an all-expenses paid trip to receive their award from AWIS.

Any queries about making a nomination or the award should be emailed to awis.auckland@gmail.com

The inaugural award was made in 2014 to Dr Judith O'Brien of the University of Auckland (see page 60). Nominations for the 2015 award will be open in March 2015.

The award is named for Dame Miriam Dell, Patron of AWIS, botanist, secondary school teacher and advocate for women's advancement.

Dame Miriam's career in science (in her own words!)

I graduated in 1944 from Auckland University College (as it was back then) with a BA, majoring in History and Botany. I went on to do honours in Botany mainly because my brother had all the textbooks. I was pipped for a Senior Scholarship by Anne Wylie, a student from Otago. I got first class in my honours papers and was again pipped by Anne Wylie. We have been good friends ever since!

When we moved to Wellington I wanted to finish my thesis so went up to Victoria to start the process. At that time there was some sort of feud between the Botany departments and the Professor would not let me continue with the research I had begun in Auckland. He insisted I take a paper in Statistics and would not approve my thesis subjects. So I became fed up and had a baby instead! So much for a career in Science!*

However, I had trained as a secondary school teacher and taught Science for many years. I taught also at night school to students in the pharmacy courses. Some of those students have had distinguished careers in Botany, much to my satisfaction.

My brother, Professor R.E.F. Matthews of Auckland University, was a brilliant scientist and a Fellow of the Royal Society of London as well as the Royal Society of New Zealand. He also held many other important posts. My husband, Richard Dell, worked for his DSc after we were married in 1946 (there was no PhD then!). He was a leading authority on Cephalopods, among many other things, and Director of the National Museum.

*Editorial note: Science's loss has been women's gain, both nationally and internationally, as Dame Miriam Dell has devoted most of her life to promoting women's advancement and equal rights in society. She has served on a wide variety of community, government, and international organisations. These include the National Council of Women, of which she was National President from 1970 to 1974. Then she was the first New Zealander to become President of the International Council of Women (ICW), holding this office from 1979 to 1986, and was in charge of the ICW's Third World Development Programme until 1991.

She was Chair of the Committee on Women, the forerunner to the Ministry of Women's Affairs, from 1974 to 1981, and Chaired the 1993 Suffrage Centennial Year Trust. She also served on the New Zealand National Commission for Unesco, and has been involved with the Social Security Appeal Authority, International Year of the Child, and the Advisory Committee on Women and Education.

She was made Dame of the Order of the British Empire in 1980, and appointed to the Order of New Zealand in 1993.

What a difference a mentor can make

Judith O'Brien*
School of Biological Sciences, University of Auckland, Private Bag 92019, Auckland 1142

What will motivate you to get up each morning and go to work? This is one of the questions I raise with students when discussing programme choices and the careers they may lead to. For me the answer to that question is having the opportunity to contribute to good decision making by the staff and students I work with in the School of Biological Sciences (SBS) at the University of Auckland.

Excellent mentors have made a significant contribution to the twists and turns of my career, the earliest one being my mother, who was passionate about enabling her daughters to be well educated so that they would have real career choices. We were sent to Baradene, a relatively small Catholic girl's school in Auckland, and I was fortunate to be taught by some dedicated and progressive women during my time there. The first key decision point for me was whether to continue with arts or sciences when I arrived at university. These days a conjoint BA/BSc would have been the obvious solution, but in the absence of that option I elected to go for the science route because I felt it could lead to a wider range of careers. I majored in biochemistry and microbiology at the University of Otago and then transferred to Auckland to enrol for an MSc in the Department of Cell Biology.

At this point I met the mentor who would have the most profound influence on my career, my supervisor Dick Bellamy. At our first meeting he expressed great interest in having me as a graduate student in his lab and outlined possible projects investigating the structure and replication of a double-stranded RNA virus he was studying. He then gave me the first of what would be many sage pieces of advice – I was sent away to talk to a number of other potential supervisors in order to give me the best chance of choosing a compatible supervisor and a research topic that would really work for me. I immediately noticed that not all academics operated this way – I had an excellent undergraduate record and some of them pushed quite hard for an immediate decision to join them. Altruism, I have come to realise, is a key characteristic of good mentors.

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Another sign of a good mentor is one who expands your horizons by making you aware of options you may not have considered. Dick proved to be an excellent supervisor, readily available to explain the science, quick to articulate the value of my work, and soon encouraging me to think about continuing on to a PhD. This was not something I had thought about – nobody in my family had a university degree and at that stage another 3-4 years' study seemed like a life sentence on top of the 4 years I was completing. By the end of my MSc year I trusted his judgement enough to line up a PhD scholarship, but I also had some other options – my best friend thought it was time we were setting off on our OE and my boyfriend had just graduated with an engineering degree and taken a job at Forest Products in Tokoroa. It was with some trepidation that I took Dick out to lunch to confess to him that I had applied for secondary teacher training – what else was a girl to do if she planned to move to the middle of the North Island?

After three years' teaching high school chemistry and maths, I came to the conclusion that I loved working with students who wanted to learn, but I was not the right person to convert the ones who had alternative ambitions. I also realised how much I had enjoyed research so we decided to move back to Auckland and see what we could find. Dick and I had stayed in touch after I left his lab and when I told him about our plans he helped me find someone with funds to employ me. Fortunately the contract was a short-term one because a few months later I learned that we were about to start our parenting career by having twins! I thought this might be the end of Dick's plans for me but his next suggestion was a crucial one – when the boys were about 18 months old he asked me if I would teach the lab component of a large Stage 1 course in which he was developing a cellular and molecular biology module. Daycare was not well established (or accepted) in those days in New

Judith O'Brien is Deputy Head (Development) in the School of Biological Sciences at the University of Auckland. Dr O'Brien's research interests focus on the structure and replication of double-stranded RNA viruses and she teaches cell and molecular biology in large first- and second-year courses. She was responsible for the coordination of SBS teaching activities from 2001 to 2011, and her current role includes mentoring of postgraduate students, research fellows and newly appointed lecturers in the School. Judith was the inaugural recipient of the AWIS Miriam Dell Award for Excellence in Science Mentoring in 2014.

Zealand but my mother was very supportive and promised to look after the boys for the month I would be working. The plans were almost derailed when she broke her leg not long before the teaching was to start, but I found an alternative carer and began what was to become an annual break from suburbia for the next eight years (also producing two more babies along the way). Apart from mentally recharging my batteries, this utilised my teaching experience and kept me in touch with science at a time of rapid change – in Dick's lab we were learning how to manipulate DNA and clone rotavirus genes, techniques unheard of when I was an MSc student.

Despite my occasional disregard for his advice, Dick was endlessly patient and continued to suggest that I come back to work part-time. Eventually I did just that, signing on as a part-time, temporary junior lecturer in 1988 when my youngest son was 2 and the other three were all at school. My funding was cobbled together from university and HRC sources, and over time, Dick increased it by building increasing support into new grants he was writing. A key contribution to the success of this arrangement was that he supported my family priorities and was very understanding when broken limbs and notifiable infectious diseases disrupted my childcare arrangements. The academic learning curve was intimidating, given how long I had been away from science, but my annual teaching stints meant I had good networks in the department and I had great lab mates who were always prepared to answer my many questions. The matter of my now long-overdue PhD was mentioned from time to time and even though I was not completely convinced it was something I could fit in to a fairly busy phase of my life, I enrolled part-time once all the boys were at school. My career would have been very different if Dick had not continued to look for ways to make this happen, and it also gave me valuable training in the art of graduate supervision, a significant component of mentoring activities in the university environment.

I graduated with a PhD in Biological Sciences in 1997, by which time I was lecturing in undergraduate cell biology courses and, together with another postdoctoral fellow, looking after the day-to-day running of Dick's lab as he was by then the inaugural Director of SBS. I had published three papers during my PhD and was Associate Investigator on a number of successful grant applications, so my skill set had increased significantly since I left suburbia ten years earlier. I was by then 0.8FTE and very happy with this arrangement but I was about to leave my comfort zone again, care of my illustrious mentor. In 2001 Dick was appointed Dean of the Faculty of Science and his next suggestion was that I step up to the role of Deputy Director (Academic) in SBS to support his replacement, the previous DDA. My secondary teaching background was seen as a significant advantage because we were establishing the model of large Stage 1 core courses at that time so it was important to understand the school-to-university transition. Raising four small boys had also taught me excellent strategies for people management!

I was to serve as DDA for ten years and it was during this time that I had the opportunity to start doing some mentoring myself. I no longer had time to act as primary supervisor, but I continued to teach in undergraduate courses and also became more involved with advising students contemplating the transition to postgraduate programmes. At this time we also began to see changes in employment behaviour; pre-2000, resignation from a tenured academic position was unusual but funding based on university rankings and increasing competition for grant support changed the landscape. As vacancies arose we recruited a number of young postdoctoral fellows to balance our top-heavy staff profile and I quickly realised that there was an urgent need to mentor their transition to their new role rather than relying on them picking up what they needed by random chance and/or some sort of academic osmosis. The University's mission of increasing PhD registrations also resulted in more competition for postdoctoral fellowships and in SBS quite a number of those appointed aspired to permanent positions here rather than the more mobile, internationally focused pattern of the past.

The opportunity to create my own version of what I have experienced for a new generation of young scientists has been uniquely satisfying. The digital era has provided many advantages and efficiencies, but students still need access to good personalised advice. Common examples include decisions about whether to proceed to further studies or start looking for employment, how best to compete for scholarships or places in prestigious programmes, and the advantages and disadvantages of staying in New Zealand v. going overseas. My current staff development role focuses on recruitment, early-career support, career planning via the annual performance review process, and coordination of the preparation of applications for promotion. My approach owes much to the strategies Dick used and, having experienced significantly affirmative attitudes during my own career, it is a special privilege to act as a role model for female students and staff. I am committed to the creation of a culture that makes it possible to combine family and career aspirations in science and I was deeply honoured to receive the inaugural AWIS mentoring award from Dame Miriam Dell in July 2014.

So how do you find a mentor? There is often a significant element of serendipity and personal chemistry is also an important factor but knowing you need one is a good start. In science likely candidates will include academic advisors, your lecturers, postgraduate or postdoctoral supervisors and senior colleagues. Be prepared to take the initiative and don't expect it to be a one-way relationship – many of my mentees have come to me in another context but took up my invitation to make use of my open-door policy in the future. Over time they have given back to me in many different ways and a good number have maintained the contact once they have left university. Perhaps the greatest satisfaction for a mentor is to see new ones emerging, becoming successful in their own careers and paying you the ultimate compliment of treating others the way you treated them. Being a part of this mentoring cycle ranks as a highlight of my career.

AWIS Conference paper

Maternity, metrics and morale: Addressing the continued attrition of women from science

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[3]Truckee Meadows Community College, 7000 Dandini Boulevard, Reno, Nevada, USA

Women continue to be under-represented in science careers globally, despite decades of awareness of gender issues in STEM[§] (Shen 2013, Larivière *et al.* 2013). While in some fields, women are under-represented at all career stages, in other fields (particularly biological sciences) an increasing number of women are attracted into undergraduate programmes (O'Brien & Hapgood 2012, Moss-Racusin *et al.* 2012). However, even in fields in which women outnumber men in undergraduate programmes (like ecology, Martin 2012), women are increasingly under-represented with advancing career stage, suggesting either a glass ceiling preventing career advancement (e.g. Dobele *et al.* 2014), or a leaky pipeline effect, whereby more women than men leave science without career advancement (e.g. Pell 1996). These factors suggest a very different experience of the science career environment by men and women.

A variety of factors contribute to the attrition of women from sciences. We recently suggested that the differences in the experience of science between men and women result in key sex differences in publishing behaviour, mediated through these societal influences (Cameron *et al.* 2013, Figure 1). Even before entering science careers and during undergraduate study, societal influences suggest that science is a masculine pursuit (Barres 2006). This is reinforced in textbook examples and role models, almost exclusively male despite contributions of female scientists (Damschen *et al.* 2005). Lack of competence is reinforced by implicit bias, with females judged less competent, and males judged worthy of a higher starting salary with identical qualifications (Moss-Racusin *et al.* 2012). Consequently, women have less confidence in their scientific abilities even before their careers begin. Nonetheless, the representation of women in undergraduate and postgraduate study continues to

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[§]STEM: Science, Technology, Engineering and Mathematics.

Elissa Cameron works on the ecology, behaviour and conservation of mammals, occasionally including humans! She did her undergraduate and masters degrees at the University of Canterbury, and PhD at Massey University.

Elissa then did postdocs overseas, in Australia and then South Africa. Her first faculty position was at the University of Nevada, Reno, before she returned to South Africa as the Director of the Mammal Research Institute.

Since 2010 she has been Professor of Wildlife Ecology at the University of Tasmania, Australia.

Angela White is a research ecologist with US Department of Agriculture Forest Service, Davis, California. Her interests lie in understanding how temporal and spatial environmental heterogeneity impact species' distribution, abundance and reproductive success. The focus of Angela's work is integrating her research with management-based questions.

Her undergraduate degree was taken at the University of California, San Diego, and her masters degree at San Diego State University. Her PhD in ecology, evolution and conservation biology was taken at the University of Nevada, Reno.

Meeghan Gray is college instructor in the Biology Department of Truckee Meadows Community College, Reno, Nevada.

She received her BS in Animal Science from California State Polytechnic University, Pomona, in 2001 and her PhD in ecology, evolution and conservation biology with respect to feral horse contraception at the University of Nevada, Reno.

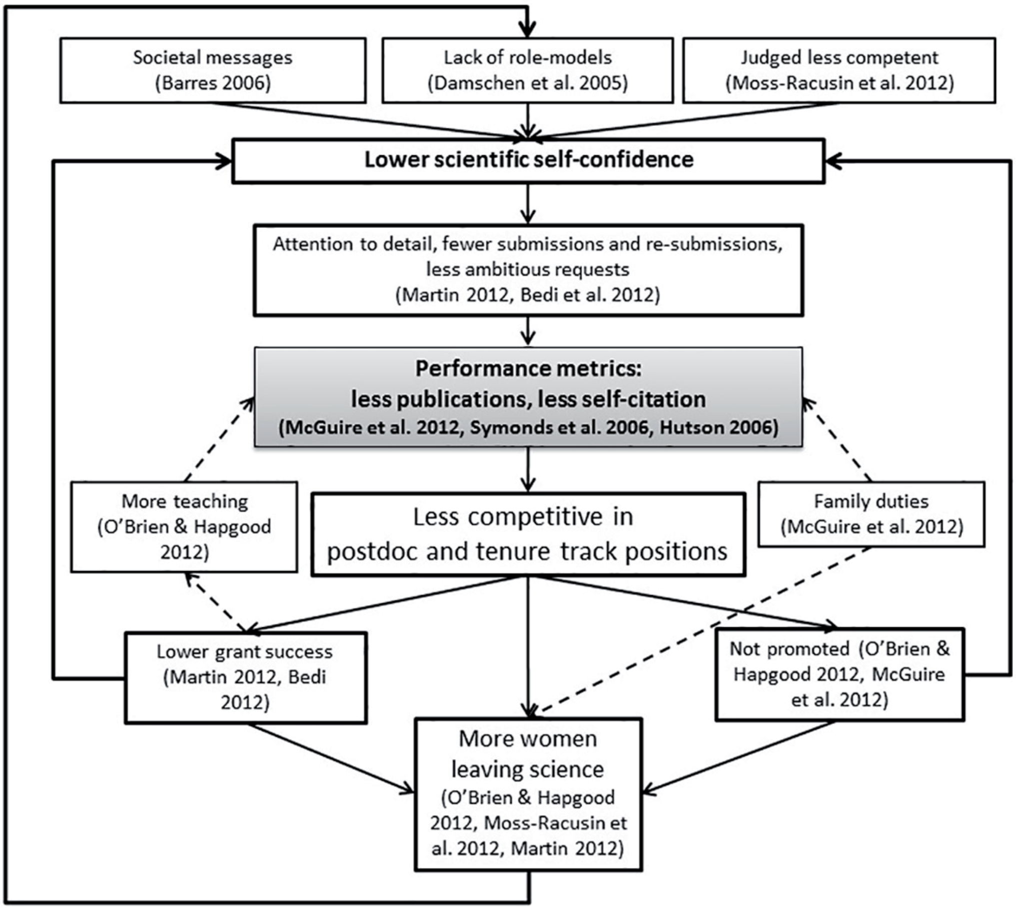

Figure 1. Diagrammatic representation of the relationships between the experience of science, low scientific self-confidence, and the attrition of women from science. (Adapted from Cameron *et al.* 2013.)

grow, suggesting that these factors do not prevent women from initially considering science as a career.

During the early post-PhD career, small advantages can disproportionately influence future success ('Matthew Effect', Petersen *et al.* 2011, DiPrete & Eirich 2006). If women already have a lower scientific self-confidence, an increased attention to detail results in fewer journal submissions (Martin 2012) and less ambitious funding requests (Bedi *et al.* 2012). Implicit bias contributes, as women are cited less often (Davenport & Snyder 1995), compounded by women citing their own work less often than do men (Hutson 2006, Cameron *et al.* in review), resulting in lower h-indices for women than men (Cameron *et al.* in review). Thus, for both commonly used performance metrics (publication rate and impact), women score lower than men (Cameron *et al.* in review).

Performance metrics impact all aspects of the later career. Lower scores on performance metrics result in less grant success (Martin 2012), compounded by more moderate requests for funding (Bedi *et al.* 2012). This can lead to higher teaching loads (O'Brien & Hapgood 2012), and lack of promotion (O'Brien & Hapgood 2012, McGuire *et al.* 2012). These sexually dimorphic patterns are compounded if women take time out from their careers for family duties (McGuire *et al.* 2012), which can coincide with the period of intense competition associated with gaining a faculty position (Adamo 2013), all resulting in less time spent active in research. Importantly, women leave science at all stages from early to late career (O'Brien & Hapgood 2012, Moss-Racusin *et al.* 2012, Martin 2012), reinforcing the lack of role-models in science, and beginning the cycle again.

Many of the factors influencing the attrition of women from science are difficult to change quickly. For example, implicit or unconscious bias is difficult to change quickly, especially amongst scientists who consider themselves unbiased. Indeed, perceiving oneself as objective has been shown to be associated with greater gender bias (Uhlmann & Cohen 2005). The bias also increases with the prestige of an organisation (Sheltzer & Smith 2014). Therefore, unbiased performance metrics should increase the representation of women in STEM fields. If, however, metrics are biased against women, these metrics could contribute to the attrition of women from science. Here, we demonstrate the effect of removing self-citations on the evaluation of women faculty members in ecology, a field dominated by women in undergraduate and postgraduate levels, but still under-represented among employed faculty (O'Brien & Hapgood 2012).

We identified ecology-related faculty members in universities in New Zealand, Australia and South Africa from website profiles. We used only those who published their first paper between 1980 and 2007, thereby minimising both historical effects and early career variation, and who were still actively publishing (at least 1 paper in the last 5 years). The resulting sample was 85 women and 105 men. We then used Scopus to document their publication career, recording year of first publication, total publications, H-index (Hirsch 2005) and total citations. We then excluded the citations of the author themselves (i.e. still including co-author citations), resulting in an H-index excluding self-citations, which we called H(ns), and total citations excluding self-citations. These enabled us to calculate the percentage of an author's citations that were by themselves, and the difference this made to their H-index.

There was no significant difference in year of first publication between the males and females (t_{188}=1.59, p=0.11). Men published significantly more than women across their career (men 60 papers, women 42, $t_{188} = 3.69$, $p = 0.0003$), confirming other studies (e.g. Symonds *et al.* 2006), although some studies have shown the pattern to be decreasing among early-career researchers (e.g. van Arensbergen *et al.* 2012). Women tended to have more citations per paper (men 19, women 26), as seen in previous studies (e.g. Addessi *et al.* 2012) but the differences were not significant ($t_{188} = 1.55$, $p = 0.12$). This provides limited support for the suggestion that, in ecological terms, women follow a relatively more K-selected strategy*, investing more in each individual manuscript, while men invest more in productivity, a more r-selected strategy (Cameron *et al.* 2013). Nonetheless, men had higher H-index scores (Figure 2, $t_{188} = 2.4$, $p = 0.02$). However, there was no difference in the H-index if self-citations were excluded (Figure 2, $t_{188} = 1.54$, $p = 0.14$), since men self-cited more than women (Figure 3, $t_{188} = 3.11$, $p = 0.002$), which made a significant difference to their H-index (Figure 3, $t_{188} = 2.75$, $p = 0.007$). The extent of H-index inflation by self-citation ranged from 0 to 4 in women, but 0 to 9 in men. Almost half the women (49%) had no change to their H-index when self-citations were excluded, compared to 17% of men. Conversely, almost half the men (48%) had an H-index that was higher by 2 or more points when self-citations were included, compared with only 19% of women. Consequently, including self-citations in the H-index (the most common practice), advantaged men more than women, in some cases by significant amounts.

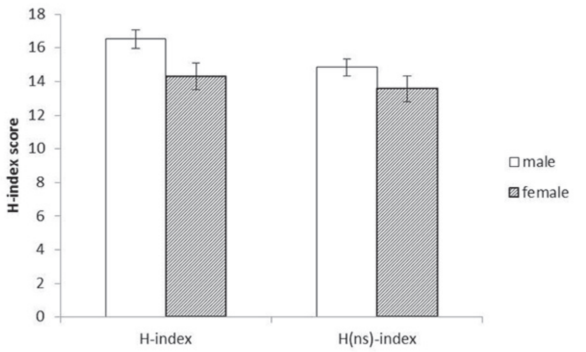

Figure 2. H-indexes for men and women, without and with self-citations included.

The average rate of self-citation was consistent with previous studies (around 10%, Leblond 2012, Wallace *et al.* 2012, Slyder *et al.* 2011), but the variation between sexes calls into question the conclusion that strategic self-citation has only a short-term effect (Engqvist & Frommen 2008, but see Purvis 2006). Some H-indices were dramatically affected by self-citation, and there was a significant gender impact, consistent with other studies (Hutson 2006, Cameron *et al.* in review). Simply excluding self-citations makes the H-index a more equitable measure. Furthermore, self-citation indicates little about the impact of research such that its exclusion should not disadvantage any researchers.

In conclusion, many issues remain to be addressed (e.g. education about implicit bias, Jackson *et al.* 2014; making workplaces more flexible, O'Brien & Hapgood 2012); an important first step to ensure better equality is to ensure that presumed objective measures of scientific achievement are not biased. Several other authors have advocated for the importance of equitable measures of research performance (e.g. McNutt 2013, Shen 2013, Cameron *et al.* 2013, Symonds *et al.* 2006). The use of equitable measures may be particularly important during the early career, when small advantages can influence the career trajectory (Petersen *et al.* 2011). Here we show that a simple adjustment (excluding the authors own self-citations) would promote gender equity, and be more equitable generally.

* Analogous to the ecological evolutionary 'strategies', K-selection, for those species that produce few 'expensive' offspring and live in stable environments, and r-selection, for those species that produce many 'cheap' offspring and live in unstable environments.

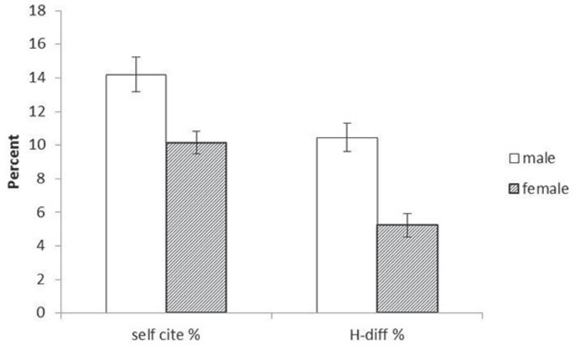

Figure 3. Self-citation rates for men and women and their effect on the H-index.

Acknowledgments

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Sex on the brain: Contradictions in the neuroscience of sex

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A contradiction exists within the neurosciences on the issue of sex. On the one hand, it is increasingly clear that there are important differences in brains as a function of sex, and to ignore these differences is a disservice to both men and women. On the other hand, research that draws on findings in neuroscience to explain sex differences in behaviour has been called out as 'neurosexist'. In this article I'll make the case for keeping sex in the neurosciences, outline some of the ways research can be misinterpreted (by both scientists and the public), and clarify what neuroscience can, and can't, tell us about men and women.

There are several reasons why we should consider sex when studying the brain. Men and women differ across a host of biological and environmental variables. They differ genetically and hormonally, with consequences for almost all biological systems, including the brain (McCarthy *et al.* 2012). They also differ in peer and parental influences, socialisation, expectations, and life experiences (Fine 2013). Any of these factors (and others) can affect the brain and subsequent behaviour. Some behavioural sex differences are quite large; for example those in sexual attraction and behaviour, aggression, or interests (Carothers & Reis 2013). Others are quite small, including those in many cognitive abilities (Halpern 2012). The mere existence of these differences, of course, says nothing about their causes, consequences, or malleability. But to the extent that all thoughts, feelings, and actions are generated by the brain, we can learn more about these behaviours by considering sex differences in their neural correlates.

Sex differences are critical to understanding a number of brain-based disorders. Depression, for example, is twice as common in women as in men (Nolen-Hoeksema 2001). Women also suffer from higher rates of anxiety, eating disorders, multiple sclerosis, and Alzheimer's disease. Men in contrast have higher rates of impulsivity, autism, Parkinson's disease, and adolescent-onset schizophrenia (Abel *et al.* 2010; Arnett *et al.* 2014; Eaton *et al.* 2012; Miller & Cronin-Golomb 2010; Voskuhl & Gold 2012; Werling & Geschwind 2013). Any neuropsychologically valid theory of these disorders therefore has to consider the role of sex in etiology, manifestation, and treatment. Again, the existence of difference says nothing about cause. Consider depression, a complex disorder that surely has genetic, neurochemical, cognitive, experiential, psychosocial, and cultural determinants - any combination of which can differ for men and women. Regardless of its causes, the constellation of thoughts, feelings, and actions that define depression are instantiated in the brain, making the brain a critical component in any understanding of why depression so inequitably targets women.

Disregard for sex differences can have serious consequences. A well-publicised example is the dose recommendations for the sleep medication zolpidem (Ambien), the most widely-prescribed hypnotic drug worldwide (Greenblatt *et al.* 2000, 2013). Zolpidem was in wide use before it was recognised that women achieved higher blood concentrations of the drug than men, even after adjusting for bodyweight. More worrying, the drug also had more profound effects on fatigue and concentration in women, even after adjusting for blood concentrations. Thus men and women differ in both the metabolism of the drug and in its psychological effects. The US Food and Drug Administration only altered its recommended dosing for zolpidem in women in 2013, more than twenty years after it first appeared on the market (US FDA 2013).

Problems like these can arise because much medical (including neuroscience) research includes only male laboratory animals, based on the assumption that non-reproductive systems should not show sex differences. Using only one sex reduces variability between animals and so maximises ability to observe experimental effects. Female animals are assumed to have additional variability related to hormonal cycles, and co-housing of males and females introduces additional complications. The use of only male animals is therefore efficient and cost-effective, but only if effects in males generalise to females. But in many domains they don't. In response to this problem, the National Institutes of Health has recently called for a wholesale change in preclinical studies to include both male and female animals and cells (Clayton & Collins 2014).

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In humans, sex differences can go unnoticed because researchers simply do not look for them. Researchers may include both men and women in their studies, but then not analyse sex differences or even report the sex of their participants. An example can be drawn from the area of pain research, where research prior to the 1990s rarely considered the sex of participants (Berkley 1997). But it is now clear that women have lower pain thresholds than men in experimental settings, are more likely to report clinical pain, and show a reduced therapeutic response to analgesics (Bartley & Fillingim 2013; Mogil 2012). This 'don't ask, don't tell' approach is still common in many research areas in psychology and the neurosciences. Most concerning is that scientists may actively avoid sex difference research because they are concerned about the consequences of their findings. Sex differences are likely to draw unwelcome media attention that can drown out more important scientific findings or distort results to create controversy. Scientists can be stigmatised simply for pursuing sex difference research. Larry Cahill, a neuroscientist who studies sex differences in the amygdala (a brain structure that plays an important role in emotional processing) writes that he was advised by senior colleagues that studying sex differences would 'kill' his career (Cahill 2014). I was similarly advised that sex differences are peripheral to important questions in cognitive neuroscience and not a suitable topic of study for a serious scientist.

An avoidance of sex difference research in the neurosciences stems partly from concerns about neurosexism (Fine 2013) – the use of neurological findings to support a sexist status quo. Neurosexism reflects some important misunderstandings about brain research and about what neuroscience can, and can't, tell us. A recent study on sex differences in connectivity illustrates some of these misunderstandings. In a study published in the Proceedings of the National Academy of Sciences, Ingalhalikar and colleagues (2013) used a process called diffusion tensor imaging (DTI) to map the major myelinated pathways in the brain. The process produces a structural connectivity map (or *connectome*) that quantifies the strength of connections between different brain areas. They divided the brain up into 95 small segments, or parcels, and examined the connection strength between each pair. This produced almost 9000 potential connections.

In a large sample of 949 adolescents and young adults (ages 8–22), they found that some (but certainly not all) of these pathways showed sex differences that emerged in adolescence. Of the pathways that were stronger in men than women, almost all were intrahemispheric; they connected brain areas within the same cerebral hemisphere. In contrast, most of the pathways that were stronger in women than men were interhemispheric; connecting homologous areas in the left and right hemispheres. This structural map is largely consistent with decades of research suggesting that women are less lateralised than men, and that they have better communication between left and right hemispheres. The study makes some important contributions to the literature. DTI is a relatively new technique that allows us to map structural connections between brain areas, which are emerging as important factors in understanding brain function. This research team are pioneers in the technique, and this is one of the largest studies conducted to date to produce such a detailed map.

The media response was swift, and came in two phases. The first appeared in the mainstream press: *Vive la difference* (*Economist* 2013). *Male and female brains wired differently, scans reveal* (*The Guardian* 2013). *Differences in how men and women think are hard-wired* (*Wall Street Journal* 2013). *The Independent* (2013) led with a wordy headline, *The hardwired differences between male and female brains could explain why men are better at map-reading*. The second wave consisted of the backlash: *Getting in a tangle over men's and women's brain wiring* (*Wired* 2013). *Be wary of studies that claim men and women's brains are wired differently* (*New Republic* 2013). *The most neurosexist study of the year*? (*Slate* 2013). *Men are NOT from Mars after all* (*Daily Mail* 2014).

The media attention (both pro and con) focused largely on 'hardwiring' – a term that does not appear anywhere in the published article. The term reflects the assumption that brain structure and function are innate, coded in our DNA, as nature intended us to be. The extension of this assumption is that men's and women's innately different brains provide an explanation for all the myriad ways that men and women are different. But this assumption is wrong on a number of counts. Most importantly, brains reflect both genetic and environmental influences. Brains are certainly constrained by our biology. I can talk and my dog cannot, and I am fairly confident that the difference stems from fundamental differences in our brains that are coded in our genomes. But, brains (especially human brains) are also plastic. Every skill we learn, every fear we acquire, every memory we create, alters brain structure and function (Zatorre *et al.* 2012). The fact that connectivity differences emerged in adolescence is consistent with the idea that they reflect, at least partially, the different experiences of boys and girls. However, it is also consistent with hormonal differences with adolescent onset. To the extent that two groups of people (like men and women) think or act differently, *for whatever reason*, those differences will show up in their brains – it is inevitable. It would be much more remarkable if two groups of people exhibited different behaviours yet had identical brains! The focus on the brain as hardwired reflects the hope that somehow the brain could give us the answer to the age-old (but ill-conceived) question of nature vs. nurture. But neuroscience can't answer that question, because nature and nurture will both be reflected in the brain, intimately entwined. Neuroscience can't explain the 'why' of sex differences, but it can help us to understand 'how'. And understanding 'how' is a critical step toward the goal of better understanding of the human condition.

A further misconception surrounding the study by Ingalhalikar and colleagues is that their reported sex differences in structural connectivity explain any sex differences in behaviour. The study did not assess behaviour, and so it is impossible to make that link – although that should be a goal in future research. The authors are guilty of making this assumption themselves. Although the research team may have considerable expertise in structural imaging, they do not appear to know much about sex differences. They speculate that 'male brains are structured to facilitate connectivity between perception and coordinated action, whereas female brains are designed to facilitate communication between analytical and intuitive processing modes'. Although they may not use the term hardwired, they imply that behavioural differences arise through pre-existing neurological mechanisms. More seriously, they link their structural differences to popular (mis)conceptions of sex differences in athletic skills and intuition, and not to those in well-documented (and well-defined) constructs. They also draw on folk theories of the cerebral hemispheres when they refer to women's ability to connect the 'analytical and sequential reasoning modes of the left hemisphere with the spatial, intuitive processing of the right'. In the media these claims were exaggerated even further, with this structural difference explaining why women are more nurturing and men are better hairdressers.

And yet a further misconception is that these connectivity effects are large or profound. This misconception stems partly from sloppy language – we say 'women have stronger interhemispheric connections' by which we mean that people differ in their interhemispheric connections, but the mean connection strength in women is greater than the mean connection strength in men. The connection strengths can be described by two overlapping distributions. A study with a sample size of greater than 900 can reveal very small but statistically significant differences. Although the authors don't report an effect size for any of their sex differences, Ridgway (2013) calculated them based on the statistics in the paper, and found that for the largest interhemispheric difference, connection strength was 0.3 of a standard deviation greater in women than men. We can consider what that means in real terms. If I assumed that anyone with values greater than the overall mean was a woman, and anyone with values less than the mean was a man, I would be right 56% of the time.

The magnitude of the effect is exaggerated by a figure that is included in the paper, and that was widely reproduced in the media. It presents a brain showing only those connections that are stronger in men than in women (almost all of which are intrahemispheric) and another showing only those connections that are stronger in women than in men (almost all of which are interhemispheric). The resulting image looks like a pair of wiring diagrams of the typical male and female brain, which are so strikingly different 'that they might almost be separate species' (*Daily Mail* 2013, 2014). Of course, the reality is that men and women have all the same connections, and the figure is just presenting those connections that are slightly stronger in men or women. The authors were criticised in the scientific literature for this misrepresentation (Joel & Tarrasch 2014). Although they explain the figure accurately in the text of the article, that explanation was lost when the brain diagrams were presented to the public.

Clearly then, neuroscience findings can be used to draw unjustified conclusions about sex differences in behaviour, and those distortions can be magnified when findings reach the public. It is worth noting that the original finding of a sex difference in connectivity is not particularly controversial and is a valuable contribution to a growing literature on sex differences in brain structure and function. Neurosexism arises through the inappropriate extrapolation of findings to provide simplistic explanations for complex and multiply-determined behaviour. The biggest danger of incidents like these is that they can lead us to brand neuroscience itself as an enemy of feminism and equality. One of the most disturbing media headlines appeared in *Popular Science* (2014): *Stop looking for 'hardwired' differences in male and female brains*. A neuroscience that ignores sex is incomplete and ineffective. The stakes are too high, for both men and women, for us to stop.

Given recent findings of important sex differences, and changes in government funding policies, I expect (and hope) that we will see more sex difference research in the neurosciences in future. The challenge will be for researchers to conduct and communicate that research responsibly. Fine and colleagues (2013) laid down this challenge: 'Scientists who work in politically sensitive and important areas have a responsibility to realise how social assumptions influence their research and, indeed, public understanding of it. Moreover, they should also recognise that there are important and exciting opportunities to change these social assumptions through rigorous, reflective scientific inquiry and debate'. A neuroscience that tackles the important question of sex does indeed seem a worthy pursuit for a serious scientist.

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AWIS Conference paper

Pride and prejudice: Why science is sexist

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It is a truth universally acknowledged, that a man in possession of a white coat and a bad haircut is more likely than any woman to be a scientist.

'Science remains institutionally sexist'. This is the claim with which *Nature* addressed the matter of women in science, in an issue dedicated to the subject in 2013.[1] The sexism referred to is evident in the lower representation of women in the scientific workforce – an imbalance made dramatically clear by the low number of female Nobel Laureates (fewer than 2% of the Chemistry and Physics Laureates to date), or Fellows of the Royal Society of New Zealand (9%), or their overseas equivalents. More pragmatically, women have lower success rates for research grants[2] and have lower citation rates[3]. There is therefore no question whether science is sexist: it is however of considerable importance to understand why this is the case – assuming, of course, that we would like to understand how to fix the current situation.

A belief in innate differences between the abilities of women and men is the only explanation that justifies the maintenance of the status quo. For this reason, it is something that every woman who participates in science will be confronted with at some point. Larry Summers, the then President of Harvard, gave an infamous version of this argument in 2005 when he argued that it was the increased variability of the male population on a number of measures – in which he conflated the measurement of height, weight, and 'scientific ability' – that explained their dominance 'at the top end'[4].

Such an argument echoes older studies that demonstrated differences in the performance of men and women – or girls and boys – on tests of mathematical skill. However, the subsequent demonstration that the effect of culture is more significant than that of sex[5], in combination with the observation that these differences have been narrowing over time, leaves little doubt that such differences are primarily due to social influences.[6,7]

Not all sex differences are necessarily false. In tests of ability with the mental rotation of three-dimensional objects, boys may have a persistent edge over girls[8]. However, the observation that socioeconomic factors affect performance on such tests leaves room to doubt any interpretation of the data along lines of 'natural' or biological differences in ability[9]. But quite beyond the existence of subtle sex differences, the idea that the very specific skill sets that these tests measure should directly translate into improved scientific ability – whatever that is supposed to be – is risible.

The literature that most convincingly provides an explanation for the gender imbalance evident in science is based on an understanding of human psychology, stereotypes, and biases. It is supported by numerous studies, which provide similar evidence of gender bias in society in general: but recent work has convincingly demonstrated these effects at work in the scientific community more specifically.

Drivers of sexism

I will discuss four major drivers of sexism in science, which seem most pertinent: actual sexism, unconscious bias, stereotype threat, and impostor syndrome. It is of some use to distinguish between these individual effects, although as we shall see, there are many ways in which they interact in a concerted fashion.

Sexism

Actual sexism – conscious, directed prejudice based on an individual's sex – is probably not the major issue for women in science. But then again, I would say that. As a woman in science, I am affected by the incongruous denial of personal advantage[10]

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demonstrated in studies of gender discrimination. In short, as with sexual harassment, women may be reluctant to admit to having been the victim of gender discrimination, despite being willing to admit that it exists.

The evidence that it exists is not lacking. For example, a recent study of the experiences of both men and women at scientific field sites clearly demonstrated the existence of sexual harassment, primarily of scientific trainees; in the case of the women respondents, the harasser was generally senior to them within the research team[11].

Unconscious bias

It is not with any intent to dismiss the significance of sexual harassment that I say that it is instead the evidence of unconscious bias that I find most disturbing. In a study led by Moss-Racusin designed to test the hypothesis of gender bias amongst science faculty members[12], male applicants were preferred over female applicants for a job as laboratory manager, despite the only difference in the application materials being the gender of the applicant. On competence, hireability, and the willingness of the faculty member to mentor the applicant, the men fared significantly better than the women. This advantage added up to an additional 12% in the salary offered, a rather credible demonstration of the origin of the gender pay gap.

Perhaps most significantly, the bias in the evaluations was not affected by the gender of the faculty member – in other words, and the reason that this should disturb us all: men and women are equally biased.

How can this be? Why would a woman act in a way that perpetuates the system of bias that is prejudicial to her own career? One answer is because the bias is unconscious. The acceptance that we are all subject to unconscious biases is, in my opinion, a necessary first step in making sense of the situation of women in science.

A key reason for the impact made by the Moss-Racusin study of gender bias, was not that the demonstrated bias was new: it was entirely consistent with previous studies of gender bias and gender schemas. However, it was the first study to explicitly demonstrate this bias amongst practicing physical scientists – though a previous study had demonstrated very similar levels of bias amongst psychological scientists[13]. As the authors state, the applicability of those previous studies could be challenged on the basis that 'science faculty members may not exhibit this bias because they have been rigorously trained to be objective'; but this is demonstrably not the case.

The role that objectivity plays in reinforcing unconscious bias – or the application of it – may not be immediately clear. A demonstration which I find particularly striking was achieved in a 2005 study of gender bias in the evaluation of the curriculum vitae (CV) of an applicant for the job of police chief.[14] The CVs evaluated demonstrate either a higher level of educational achievement, or a more significant period of practical experience, and are supplied to the participants with male and female names respectively, in random order. Several important points are clearly made in this study. The first is that the demonstrated gender bias is justified, after the fact, by the use of 'constructed criteria': the male candidate is always preferred, and the selection of the male candidate will be justified on the basis of either the greater experience or education, depending on which CV is supplied. The second major point is one of the important beacons of light in such studies: if the participants are asked beforehand to state the criteria upon which they will base their decision, the demonstrated gender bias disappears. This has obvious implications for the processes around CV evaluation that are so prevalent in science: whether for hiring, grant evaluation, or promotion.

The third major point of this study is, however, the one most clearly applicable to science. The participants are requested to evaluate their own level of objectivity, and the results are correlated with the level of bias in their CV evaluation. Those who rate themselves as highly objective are highly biased; those who rate themselves as not highly objective provide evaluations of the CVs which are almost completely unbiased.

Pride has a few different meanings, but the definition given by the Merriam-Webster: 'inordinate self-esteem', seems to fit the self-perception of objectivity. It is no great step of logic to connect this effect with the comment in the Moss-Racusin study, on the possibility of greater objectivity of scientists, and realise that here, we have a clue about what science-specific feedback loops may drive the persistent exclusion of women from science. The pride inherent in self-perceived objectivity is a predictor of persistent prejudice.

Is objectivity central to scientific identity? Certainly, it plays a role, and I am not the first to observe a correlation between scientific disciplines, which place perhaps the highest value upon objectivity – mathematics, computer science, and physics – and their gender-typing, resulting in the low representation of women typical in those disciplines.

The use of citations is a key component of metrics designed to measure the impact of a scientific work – and, when aggregated, the impact of an individual scientist's body of work. Despite significant differences between typical levels of citation in different fields, they are used as a way of comparing the value of the work performed by different scientists – most typically, in the situation of a job or grant application. They therefore have a marked influence on the careers of individual scientists.

In a recent study, science communication, a field within which there is a wide range of topics of different gender types, was chosen to study the evaluation of gender-typed topics[15]. Topics related to computers or politics were assessed as male-typed, while matters to do with children or parenting were evaluated as female-typed. Gender-neutral topics were, for example, to do with health or the media. Abstracts on all these topics were supplied to participants with either male or female author names; the study participants were then asked to evaluate the quality of the abstract. For the gender-neutral topics, no gender bias was apparent. For the female-typed topic, a female author name produced a slightly favourable evaluation of quality. But the real effect is seen for topics that are male-typed; male authors are evaluated much more favourably, with the bias amounting to a factor of five over what was seen for the female-typed topics.[16] A final point made in this study is that these evaluations of quality are mirrored in the willingness of the study participant to collaborate with the author of the abstract: these small evaluations have a significant impact on careers over time.

As in the case of the Moss-Racusin study, men and women provided equally biased evaluations. The effect of gender-typing on judgements of women's behaviour has also been well demonstrated. This disadvantages women, e.g. competent women are viewed as 'overaggressive' and 'not nice' and traditionally subservient ones as 'incompetent'[17].

Stereotype bias

The third major issue, perhaps even harder to combat than either the direct sexism or unconscious biases outlined above, is the insidious effect of gender stereotype on our self-evaluations. This is stereotype threat – the effect that our own prejudices and beliefs have on our own performance.

Science itself is strongly gender-typed – meaning that it is perceived, in the culture of which we are a part, to be a domain of male activity and excellence.[18] Such gender typing can be easily understood when one looks down the list of Physics Nobel Prize winners – especially in Physics or Chemistry, but only as a matter of degree. The duty of being a role model to aspiring women in science falls heavily upon a few sets of shoulders: Marie Curie, Lise Meitner, Rosalind Franklin. The fact that the stories of these few women are so heavily recycled in turn leads to the idea that to be a woman in science is to be special; it is to be better than the rest of one's gender. Not that these ideas are clearly formed or articulated – they do not need to be in order to have an impact on young women. And in the meantime, while women are penalised for taking the part of other women,[19] men may obtain sponsorship from senior scientists without being seen to be special cases, where women do not have such a privilege.[20]

Women who are conscious of the stereotype that women have lower mathematical ability than men will perform worse on a mathematics test than if they are told that there are no gender differences, a precondition which lowers stereotype threat.[21] These effects have since even been demonstrated to exist in national assessment data in the US, outside of an artificial laboratory setting.[22] Even the studies of mental rotation, which have previously been held up as persistent evidence of sex/gender differences, have been shown to be seriously affected by stereotype threat.[23] A broad conclusion to be made about the evidence regarding stereotype threat is that the narrative of choice surrounding the decision of women, as a cohort, to leave science – the narrative of the so-called 'leaky pipeline', which sees many women leave science after postgraduate training but before achieving an independent career – is itself a fallacy.

Imposter syndrome

This fallacy of choice is pervasive, and reinforces the kind of self-questioning doubt that could cause anyone to leave science – the dark side of scientific success, and my fourth issue for women in science: imposter syndrome.

Do I belong here? is a question that any of us might ask in a challenging environment in which it is made clear that success is not guaranteed. There has been recent attention given to the high rates of mental health issues amongst PhD students[24] – a matter which should concern anyone involved in our academic institutions. Competition is present in any career, in some degree: but academic science is particularly vicious both in terms of the duration over which career advancement is highly competitive, and by the frequency with which our work is subjected to peer review.[25] Imposter syndrome is not itself gender specific – I am in no doubt about that. But it is also clear that those who do not fit the gender schema, or gender typing of their area of specialisation, will have additional causes for self-doubt. Being the subject of one's own unconscious biases – or always in a condition of stereotype threat – can do little other than reinforce the self-doubt that already exists.

Ways forward

So what can be done? I have already touched on a few suggestions made in the relevant journal articles – but it seems like it could be useful to pull these together in some form. Just as the problems I have outlined above are liable to reinforce each other, so should the solutions to the issues facing women in science be considered as a whole.

There are three different aspects of the lack of women in science that we might wish to consider. The first issue is the recruitment of girls into science, in which attitudes towards science are of paramount importance. The second is the retention of women in science: to combat the 'leaky pipeline'. The third issue is the promotion of women into the most senior positions in science. Each of these issues deserves serious consideration and the development of practical solutions.

The lack of role models for women in science – which is to say, the historical discrimination against women which has left us with such a skewed historical record – is a real issue. Serious efforts are being made to combat the prevalent stereotypes and encourage girls to see themselves as welcome in science: the EU Commission has 'Science: It's a girl thing!'[26]; in the US, there is a White House led initiative,[27] in New Zealand, the National Advisory Council on the Employment of Women recognises the issues,[28] but on the whole, there are few direct initiatives that one can see making a measurable impact. One reason for caution may be that these efforts have been known to misfire: the original 'Science, it's a girl thing' initiative was widely panned for its video campaign which used images of young girls in heels, lipstick, laboratory coats, and safety glasses. The criticism was broadly valid, but at its extremes had issues of its own: we should be careful not to suggest that femininity itself – lipstick and heels! – conflict with a scientific identity. The recent hostile reaction to a mathematician who took on a science television hosting role in the UK, after numerous calls for such a female role model, laid bare the catch 22 that faces women who attempt to step into these roles.[29] Moreover, while we still have so few women in senior positions in science, it is not clear that requiring gender parity from our public role models does women who need to find the time to perform these roles any favours; this concern is reinforced by evidence which suggests that exposure to anti-stereotypical role models does as much good as female role models.[30] What matters is breaking the stereotype enough to dismantle the gender schema of science, and if our male colleagues are brave enough, this is something they can help with.

In the case of the information available on gender biases present in citations and evaluations of quality, the sane response which I have seen suggested is for a woman to publish using only her initials, to avoid making her gender evident to reviewers and readers. But surely, if we need more role models in science, we need to encourage women to be visible – but should we expect them to do so to the possible detriment of their own careers? This is a question with no easy answer – but it shows clearly the way that the examples given previously interact with each other: this is not a question that male scientists are ever required to consider, as they prepare a paper for publication.

Training in overcoming unconscious bias for panels and decision makers is a straightforward and cheap step to address the retention and promotion of women in science. Such programmes have already been implemented in numerous contexts:

notably, in the funding processes of the European Research Council.[31] This seems to be a necessary precondition for any approach to be successful, given that the root causes of both stereotype threat and (women-specific aspects of) imposter syndrome tightly depend on the gender schemas that dictate our societal unconscious bias. Linked to any requirement for unconscious bias training must be the collection of data on the gender of awardees or appointees, and aggregated success rates that show no evidence of gender bias should be a prerequisite for continued public funding of any institution. Practical outcomes to be expected from unconscious bias training should include a requirement for the criteria upon which any evaluation will be based to be clearly stated from the outset. None of this amounts to gender-based positive discrimination – but is there perhaps a case for that, too?

So far, I have avoided any mention of the issue that inevitably comes up in discussions about women in science: the matter of children, and the disproportionate cost to women's careers of having a family. This too is well documented: the cost to a woman's career averages 4% of earnings per child, while men, in contrast, benefit from the status that accrues to them from being the 'head' of a family, at 6% of earnings per child.[32] In another study, mothers were offered $11,000 less in salary than women without children, and $13,000 less than fathers.[33] But unless one believes that women must necessarily take on a disproportionate share of the work of raising a family, discussion of the choice to have a family is a red herring in explaining why science is sexist. The impact of having a family on a woman's career is because of structural barriers in the workplace and societal expectations that rely on unconscious biases for their survival, in the absence of direct sexism. And it gets worse: discussing the difficulties that women face in science after choosing to have a family can lead to a reinforcement of those biases. If science is harder for women who have a family, say the skeptics, then expecting gender equality in science is unreasonable. Perhaps then we should be aiming only for 25% women? 30%?

To this I say no. It is harder – currently – for women who have children to stay in science. But the children are only the proximate cause; the ultimate cause remains gender bias. This remains the key issue that we need to address.

The need for mentoring for women is a measure that is often suggested to try to keep women in science, combatting the steady outflow from the leaky pipeline. It is an interesting example, because the need for women-targeted mentoring programmes stems not from an inherent gender-difference – women are in no more innate need of mentoring than men – but because they have lower rates of access to good mentors. In my opinion, this needs to be made explicit, to combat the idea that women need women as mentors, to deal with women-specific matters. While this can at times be true, it is not generally the case, and the presumption that it is a woman's job to act as mentor to the younger women in her field is yet another inequality that needs to be challenged. This inequity is only more evident when we look to the issue of sponsorship: defined as the active promotion of a person into a position of responsibility, it sounds a lot like special treatment when one thinks about asking that this be done for more young women to promote them into a position of power. Yet, it has been argued in the business community that sponsorship is one of the key ways in which women's careers are harmed by gendered behavioural differences.[34]

The data I have discussed so far – those which are robust, and demonstrated across different contexts – indicate that the root of the problem for women in science, the origin of the multitude of barriers for women, is our own stereotypes and bias: our own minds. Surely, then, discussing these issues – raising awareness – is the best way forward?

I think the answer to this is both yes and no. On the one hand, I am certain that raising awareness of our unconscious biases is the single biggest thing that we can do as individuals to fix the problems that remain for women in science. A solution addressing the root causes of gender bias would have the advantage of being extensive: the issues faced by ethnic groups historically excluded from science (in New Zealand, Māori and Pasifika) have much in common with the issues faced by women. There is certainly cause to argue for acknowledgement of unconscious bias as a first step. However, the evidence also shows that unconscious biases are persistent: most of the studies that demonstrate them have been carried out on undergraduate students.

Reflect on that, for just a minute, before you suggest that the situation of women in science is improving in our generation, and that we should be patient.

Another question that is germane to the issue of women in science, is why there are such differences in gender representation between disciplines. In a sense, we know the answer when we ask the question: biological sciences are more female typed – because we think they are – while physics and engineering are male typed. But can we dig down a little deeper?

A suggested explanation could be based on the relationship between demonstrated bias and the self-perceived objectivity mentioned earlier. Do physics, mathematics, and engineering all value objectivity to a greater extent than the social sciences or biology, which deal with messier – or one might say more complex – objects?

Additional insight is provided by a study that demonstrated the way that gender bias was affected by environmental changes – in particular, the gender ratio of the pool of CVs being evaluated for a job.[35] If the number of female candidates falls below 25%, the gender bias found in the evaluation of those CVs increases. Being seen as special is not an advantage.

This self-perpetuation of skewed demographics defines the uneven playing field upon which we base a scientific career. Yes, the goal posts are the same height, and the length of the field the same – but the field itself is uneven, though it only exists in our minds. This needs to change, and it is very hard to conceive of a way in which awareness of unconscious bias – on its own – will achieve meaningful change. There is certainly no free market of ideas between the genders, if one accepts the evidence of gender differences in citations.

A final reason for intervention in science – which is to say, in the public funding systems which control through incentives the promotion of women in science – is provided by the recognition of the number of broader careers impacted by such biases, but where intervention is much harder. In science, funding mechanisms can be centrally tuned to drive a desired behaviour, and we can hope to do this on a sufficiently large scale that distortionary effects on individuals can be avoided. However, the same biases lead to well-documented demographic challenges for the private sector – in engineering and technology, in particular – and it is unclear whether these biases can be as effectively addressed in those environments. Surely, we must start with our universities.

There is no justification for continued inaction. The principles of science deserve to be followed without pride or prejudice.

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Article

Changing the culture: A first-hand example

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In 1998, I joined the Department of Chemistry at Case Western Reserve University (CWRU) in the USA as a new Assistant Professor. Professor Mary Barkley and I, both laser spectroscopists, were hired to build a new area of strength. That we were the first women hired as academic staff in the Chemistry Department was such a remarkable event that it made the headlines in the campus newspaper (Figure 1). Today, there are six women with primary academic appointments in CWRU's Department of Chemistry, and Barkley is the Department Chair. The fact that hiring a woman in chemistry is no longer headline material is due, in part, to a pioneering programme called ACES (Academic Careers in Engineering & Science).

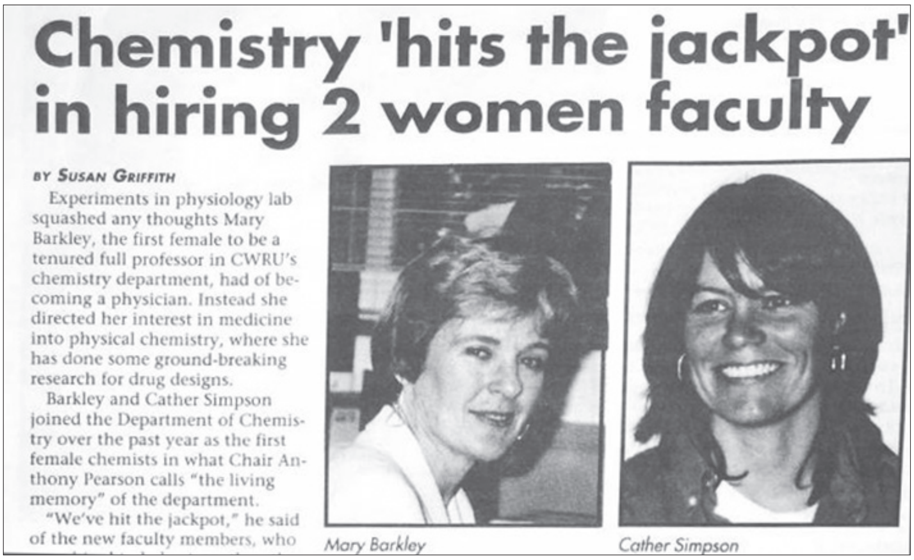
ACES was started in 2003 with the ambitious goal of transforming the institutional culture of CWRU to achieve gender equity across the campus, particularly in the challenging STEM[1] faculties. Chemistry was one of 31 pilot departments selected for intense participation in ACES initiatives. One of the key factors identified as a barrier to the advancement of women in STEM fields was underlying gender bias, and many features of the ACES programme successfully targeted that critical issue. This article gives a first-hand perspective on what it was like to be a part of this intense effort to level the playing field for women in academia.

[1] STEM: Science, Technology, Engineering and Mathematics.

Gender schemas and unconscious gender bias are now very well established, as is the fact that we all have them to some degree. These are the underlying assumptions about people that lead both men and women to be surprised when the cardiac surgeon is a woman and the nurse is a man. They impact our decision making and our assessments in ways that sometimes surprise us. I will not discuss gender bias in any detail here, but refer the interested reader to *Why So Slow*, a very knowledgeable and readable book on the subject by Virginia Valian.

The problem with bias

I was not surprised to find myself the first female Assistant Professor of Chemistry when I arrived at CWRU. I knew the history going in. However, I was surprised that being female in a science career was still noteworthy in 1998. And I was very unprepared for how much being a woman actually mattered.



Chemistry 'hits the jackpot' in hiring 2 women faculty

BY SUSAN GRIFFITH

Experiments in physiology lab squashed any thoughts Mary Barkley, the first female to be a tenured full professor in CWRU's chemistry department, had of becoming a physician. Instead she directed her interest in medicine into physical chemistry, where she has done some ground-breaking research for drug designs.

Barkley and Cather Simpson joined the Department of Chemistry over the past year as the first female chemists in what Chair Anthony Pearson calls "the living memory" of the department.

"We've hit the jackpot," he said of the new faculty members, who

Mary Barkley

Cather Simpson

Figure 1. The noteworthy event of hiring women faculty in 1998.

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Associate Professor Simpson is the Immediate Past President of the New Zealand Institute of Physics, and is now co-Chair of the New Zealand Committee for the International Year of Light (2015). In 2012, she won a Dean's Award for Teaching Excellence, followed by a University of Auckland Sustained Teaching Excellence Award and a National Tertiary Teaching Excellence Award in 2013.

In 2000, Prof. Nancy Hopkins from MIT spoke at CWRU. The previous year, she had published a study that demonstrated previously unrecognised gender inequivalence at MIT[2], and that is now largely credited with revitalising efforts to level the playing field for women in academia. As I sat in the audience, I was powerfully struck by her observation that it had taken a lot of data for her to really believe that her career had been adversely affected by her gender. That was true for me as well, and I was only beginning to recognise it in my third year as an Assistant Professor.

Like many young women of my generation, I believed that the gender battles had already been won. In retrospect, the belief that there is a level playing field for men and women is foolish – my PhD and postdoctoral years were littered with events, small and large, that should have clued me in and prepared me for the challenges of being a woman in a STEM field. Being female in science affects everything from day-to-day conversations with colleagues to success in the activities and achievements of an academic science career. The idea that the science and engineering world does not treat men and women alike is difficult to acknowledge, however.

I had been there before. I was the only girl in the entire senior baseball league in my teens[3] and I won a coveted starting position at second base in the infield. Despite the fact that there were frequent choruses of 'get that b**** off the field' from some of the parents, and that I was the only girl, my teammates and I actively maintained that there was no bias against girls in that league. We would have felt diminished, somehow, to admit there might be. The boys' achievements would have been undermined by having favored status, and I would have had to face prospect of being the token girl.

Just this year, 2014, the Fields Medal was won by a woman for the first time since the award was established in 1936.[4] Which inference feels more uncomfortable: that there may be gender bias in deciding the top mathematics awards? that this might be the first time that a woman really deserved to win one of the total of 55 Fields Medals awarded over the years? or that Maryam Mirzakhani had an advantage because the International Mathematical Union needed a woman to win?

These anecdotes point to one of the more significant challenges to levelling the playing field in any competitive arena: the participants can have a very strong vested interest in its already being level. We really do not want to believe there is bias, and we certainly do not want to believe that we ourselves exhibit it. It took people like Nancy Hopkins, Virginia Valian, Bernice Sandler, Debra Rolison and many others to help people realise that while overt, aggressive sexism is not a common problem any more, women in STEM fields suffer the consequences of gender bias. At CWRU, it was the ACES programme that helped us to recognise the gender bias and gave academic staff the tools to combat it.

Academic Careers in Engineering and Sciences (ACES) at CWRU

The National Science Foundation's ADVANCE programme provided the majority of the funding for CWRU's ACES project, in the form of a $3.5M (USD), 5-year, Institutional Transformation award. NSF-ADVANCE has awarded over $130M (USD) to tertiary education institutions in the US to 'increase the representation and advancement of women in academic science and engineering careers, thereby contributing to the development of a more diverse science and engineering workforce.'[5] This extraordinary programme started in 2001, and still going strong today[6], has these goals:

(1) to develop systemic approaches to increase the representation and advancement of women in academic STEM careers;

(2) to develop innovative and sustainable ways to promote gender equity in the STEM academic workforce; and

(3) to contribute to the development of a more diverse science and engineering workforce.[7]

NSF-ADVANCE particularly focuses on the career success of female academic staff; it does not provide support for the recruitment, retention or increased success of female students in undergraduate or postgraduate programmes.

In 2003, a team of top researchers from engineering, science and the business school, led by Lynn Singer, Deputy Provost and Professor of Environmental Health Sciences, Pediatrics and Psychiatry, was responsible for CWRU's being the first private university ever to be awarded an NSF-ADVANCE grant, and the ACES programme began. The ACES initiative at CWRU articulated an ambitious goal to 'promote a culture of equity, participation, openness and accountability at CWRU' with targeted positive impact at all three levels of the university academic staff: the university leadership, the faculty/school, and campus-wide. The team sought to achieve a 20% increase over baseline in the number of women academic staff in science and engineering with four primary activities: targeted recruitment at multiple levels, increased advancement and retention, a positive change in the institutional climate, and training and development of the academic staff for men and women at all levels. Implementation was intense, and involved a combination of accountability at the dean level, executive coaching for university, school and department leadership and for female academics, training and guidance for searching, hiring and promotion of academic staff, workshops and focus groups for all academic staff, male and female, and other initiatives.

The ACES programme was successful in increasing the percentage of female tenure-track academics in the Faculties of Science and Engineering, though the increase in numbers was not dramatic. Singer reflects now that she had hoped to solve the problem of under-representation by women in the School of

[2] 'A Study on the Status of Women Faculty in Science at MIT' with introductory comments and a list of the members of the committees that performed the study and recommended changes, the first of which Nancy Hopkins chaired, can be found at: http://web.mit.edu/fnl/women/women.html (last accessed 4 Nov 2014).

[3] Equivalent to the U15 league in the New Zealand baseball system.

[4] The official website for the Fields Medal is: http://www.mathunion.org/general/prizes/2014. The Guardian published an article about Maryam Mirzakhani: www.theguardian.com/science/2014/aug/13/fields-medal-mathematics-prize-woman-maryam-mirzakhani (last accessed 4 Nov 2014).

[5] Information about the NSF's ADVANCE programme can be found at the website: http://www.nsf.gov/crssprgm/advance/ and other links from there (last accessed 5 Nov 2014).

[6] A new round of Institutional Transformation and Institutional Transformation Catalyst awards was just made in 2014, to 9 universities. Links to these can be found at: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5383 (last accessed 5 Nov 2014).

[7] These goals are formally articulated at: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5383 (last accessed 5 Nov 2014).

Medicine, and 'ten years later [it] is clearly not solved.' Still, she wonders 'what would have happened had we not done anything.'

Equity in departmental leadership, on the other hand – in the form of departmental chair roles and endowed chairs held by women – improved much more dramatically in both science and engineering. For Singer, the 'significant advances in the percentage of women department chairs' was one of the most impressive successes of ACES. Among the most positive outcomes for her was 'inspiring women faculty to take on leadership roles and even seek them.'

New policies implemented university-wide include improved paid parental leave, partner (dual career) hiring policies, and domestic partner benefits. Several new permanent positions and programmes aimed at continued improvement in the climate for women and underrepresented groups, including a Vice President of Diversity, Inclusion and Equal Opportunity, were created from ACES. 'A transformed climate and greater success in promotion and tenure for women faculty' is a clear success of ACES, according to principal investigator Professor Diana Bilimoria, who has written about ACES in several papers, book chapters and a book *Gender Equity in Science and Engineering: Advancing Change in Higher Education*.[8] Clearly, the ACES programme was a success, and in 2008, at the end of the grant, many of the new initiatives were institutionalised at CWRU in a programme called ACES+.[9] Now the challenge at CWRU is to continue to fund the programme now that the NSF-ADVANCE grant period is over. In retrospect, Singer wishes she had raised endowment funds for the longer term.

ACES prevents the death by a thousand small cuts

By the time ACES started at CWRU, five years after I arrived, I had been forced to admit that the playing field was not level in science, and I was losing my sense of humour about it. A postdoctoral fellow balked at being asked to give a group meeting talk because he 'shouldn't have to be told what to do by a woman.' A student in the first class I taught at CWRU had answered a final examination question with some seriously hardcore pornography. One senior colleague had adopted the rather patronising habit of rubbing me on the head in the hallways as a greeting. Mary Barkley was assigned as my mentor, because we are both women. I had been asked out on dates several times after my presentations at conferences, once by a very eminent researcher in my field after he had spent 20 minutes in discussion about my research; this spurred discussions with male peers about how undermining it could be – they expressed puzzlement about why I would prefer for people to come to my talks for the science.

When women quit academic jobs in STEM fields today, I call it death by a thousand small cuts. Open, overt sexism is no longer tolerated, in the main. What is left, then, are these 'papercut' instances of bias. Each individual event like the ones described above is relatively short and sharp, but too minor to precipitate a life-changing response. I fired the postdoc, with cause, and the porn-student got into heaps of trouble. My colleague stopped patting me on the head when I asked him to. Barkley and I maintain a very positive relationship, though we both insisted at the time that a mentoring relationship should be based on something other than common sex organs. The eminent researcher did not hold a grudge after I declined his invitation – he became a useful advisor and promoted my career in numerous ways. However, by 2003, the accumulation of my 'papercuts' and those I witnessed frequently happening to others were making me frustrated.

Then ACES arrived. The ACES programme showed me how to identify and understand all of these sorts of experiences and how to combat the unconscious (and sometimes conscious) bias that often underlies them. ACES led me to a firm belief that a positive transformation of the institutional culture of STEM fields eventually could make the 'papercut' events every bit as rare as the overt sexism that characterised the previous generations' experiences.

What worked well?

Rather than give an exhaustive description of ACES initiatives, activities and events, I will describe some of my favourite parts of the ACES programme more anecdotally. A complete description of ACES can be found online (reference 9), and programmes at other US institutions designed to achieve similar goals can be found through reference 5.

At CWRU, Chemistry was chosen as a pilot department for the ACES programme, and the experience was very intense. Workshops and focus groups were held for women, men and mixed-gender groups of academics, and we were all exposed to ideas about schemas and unconscious bias. Initially, this was quite challenging and disruptive, and the climate got worse in my department before it got better. It was the same resistance that my teenage baseball team exhibited towards admitting that there might be a disadvantage to being female. Several of my male colleagues grew quite defensive about attributing any part of their success to a gender advantage. Everyone, including me, was surprised and dismayed when we began to identify gender bias in our actions and thoughts that had previously been unconscious.

The key, though, is that we were talking. The benefits of these many, many discussions soon became apparent. Women from across the university met and shared stories – and solutions. The sense of validation for many of us was palpable – we were not imagining things, most men did not experience daily 'papercuts' like we did, and it is something that we, the university and the STEM community should work to fix.

The workshops, seminars and training also eventually led to a much wider recognition of the problem; we all began to 'out' these unconscious biases and behaviour, men and women alike. We all began to count interruptions, because we learned that men tend to interrupt women in professional settings more than the other way around. Similarly, we all noticed that people got more perturbed when women interrupted. At one point in a department meeting just before I left CWRU to move to the University of Auckland, I made a suggestion to the group that was largely ignored. A few minutes later, one of my colleagues brought the suggestion up as a good idea that we should discuss further, but he attributed it to the male colleague sitting next to

[8] Bilimoria, Diana; Liang, Xiangfen 2011. *Gender Equity in Science and Engineering: Advancing Change in Higher Education*. Routledge Studies in Management, Organizations and Society. Routledge, Taylor & Francis Group.

[9] The details of the ACES programme at CWRU, the team of people involved, the results, and the continued initiatives through ACES+ are available online at: http://www.case.edu/admin/aces/ (last accessed 5 Nov 2014).

me. Most professional women in male-dominated fields have experienced this, and it can be exasperating. At that point, ACES was in its third year and just about everyone at the meeting recognised immediately what had happened, and called it out. This is a beautiful example of how knowledge of this sort of bias can defeat it.

I also became quite facile with modern research on gender discrimination, schemas and unconscious bias, and it has served me very well. For example, one year I received a raise that was far too low given my very high level of productivity that year. Because of ACES, I knew my pregnancy that year had probably had an unconscious negative impact on the assessment of my performance. I took some of the published research on this topic to the chair of my department, and he re-evaluated my record and I received a larger raise. My now extensive network and knowledge of the literature on gender bias has its roots in the ACES programme.

One place where unconscious gender bias can have a profound impact is in hiring. The ACES programme required that our hiring processes be facilitated by someone trained in recognising gender bias who would attend all of the meetings and interviews of candidates. This 'meddling' was not well received – many of my colleagues and I thought it unnecessary and intrusive. We were wrong.

I sat on a hiring committee that was discussing which of two candidates would be offered a final interview slot. One candidate had several research ideas that seemed to the committee to be scattered, though we thought she would probably be good in the first year chemistry curriculum. The second candidate seemed more focused, and had a clear back-up plan of alternative research projects if his first one did not get funded. He seemed to be an excellent candidate for our more advanced courses. At that point, the external ACES facilitator asked a few questions: each of the candidates had given us five related ideas for research – why was one 'scattered' and the other perceived as a good back-up plan? Where did the first candidate express an interest in or experience with undergraduate teaching? Didn't the second candidate say he wanted to teach undergraduates? Which candidate had published more high-profile papers? We reviewed the files and our discussion, could not articulate a reason why one was 'scattered' and the other 'careful planning', and we had indeed accidentally attributed the second candidate's interest in undergraduate teaching (a lower status activity than teaching advanced courses) to the female candidate. Our unconscious biases were thoroughly exposed, and we were then able to recognise, with some surprise, that the female candidate had also published more high-profile papers. We offered her the interview. I became very optimistic about what ACES could do to transform our institutional culture.

Many of the ACES initiatives involved activities that helped women staff members achieve. I had an executive coach from the CWRU Business School, who helped me learn to present my ideas forcefully and work to achieve positive change, to choose when to say 'no' and 'yes' to requests, and to maintain my composure in stressful and difficult situations. These and other workplace skills have served me well ever since, and I was pleased to see that ACES+ has retained executive coaching for new women academics. I was also required to have three formal mentors – one in my department, one at CWRU but not in my faculty, and one in my field outside CWRU. ACES required that I be proactive in these relationships, and these eventually became a very useful collection of resources, mentors and advocates. Perhaps more importantly, the experience taught me the value of these networks, how to form them and how to get the most benefit from (and for) them.

Other initiatives were more department-, faculty- and/or university-wide. The leadership training that all department chairs, deans and other members of the senior management team received was remarkably successful. Not only did the university leadership learn to recognise bias and combat it, they also were exposed to effective leadership strategies and tactics. Our department meetings were transformed from wandering discussions and arguments into much more highly structured conversations focused on decisions and outcomes and on achieving the agenda. The decision-making process was much more transparent, and our confidence in each other and in our leadership grew. The training did focus on gender bias, and how it affects the advancement of women, of course. I can still vividly remember discussing a colleague's tenure case, after receiving tenure and promotion myself. The department chair reminded us that it is common for women's achievements to be underrated, even by supportive colleagues, and that we should have one more look at our evaluation in that light to make sure that we had not done that. Five years earlier, before being department chair, this same person did not really believe in unconscious gender bias. Now, he was aware of it and reminded us to be on our guard for it. This is how cultures transform.

The New Zealand Association of Scientists Awards for 2014

Marsden Medal 2014

The **Marsden Medal** is awarded for a lifetime of outstanding service to the cause or profession of science, in the widest connotation of the phrase.

In 2014 we are awarding the Marsden Medal to two equally deserving scientists.

Professor Mick Clout, University of Auckland

Mick Clout is Professor of Conservation Ecology at the University of Auckland. He is a vertebrate ecologist and has worked on a range of invasive mammals and threatened native birds, first with the Department of Scientific and Industrial Research and then the Department of Conservation, before joining the University of Auckland in 1993. He established the Invasive Species Specialist Group of the Species Survival Commission of the International Union for Conservation of Nature (SSC/IUCN) and led it for 15 years, and has also served as chair of the Kakapo Scientific & Technical Advisory Committee since 1995 and the Biosecurity Ministerial Advisory Committee since 2005. His primary research speciality is the ecology and behaviour of vertebrates, but he has broad interests in applications of ecological science to national and international problems in conservation and biodiversity management. He has been honoured with the Sir Peter Scott Award for Conservation Merit (2008), the Charles Fleming Award for Environmental Achievement (2007), and the NZ Ecological Society Award for Ecological Excellence (2007). In 2010 he was elected Fellow of the Royal Society of New Zealand. Mick has served his discipline with distinction and the cause of conservation in New Zealand with great zeal and effect.

Professor Keith Hunter, University of Otago

Professor Keith Hunter is a recognised leader and innovator in environmental and chemical oceanography. His research is characterised by the application of fundamental chemistry to the investigation of oceanographic systems and the role of trace elements and, recently, CO_2 in ecological and biogeochemical processes. He has co-authored over 140 publications, including papers in *Nature* and *Science*, and his research has been supported by many Marsden and Foundation for Research, Science and Technology research grants. His close collaboration with scientists at the National Institute of Water and Atmospheric Research has resulted in the establishment of a joint Research Centre in Chemical Oceanography. In recognition of his contribution to New Zealand and international science, he was made a Fellow of the Royal Society of New Zealand, elected as a member of the American Geophysical Union, invited to chair international working groups, and was awarded the Prime Minister's Science Prize in 2011 and the University of Otago Distinguished Research Medal. Keith has held significant administrative positions for the Royal Society of New Zealand and the University of Otago and is currently Pro-Vice Chancellor (Sciences) at Otago.

Shorland Medal 2014

The **Shorland Medal** is awarded in recognition of major and continued contribution to basic or applied research that has added significantly to scientific understanding or resulted in significant benefits to society.

Professor Wei Gao, University of Auckland

Dr Wei Gao is a Professor of Materials Science and Engineering at the University of Auckland. He received his DPhil from Oxford University in 1988, and worked at Massachusetts Institute of Technology for 5 years as a Research Fellow. At the University of Auckland, he leads a research group of 30 people, and has made significant contributions in a wide area including nanomaterials, thin films and coatings, light alloys, corrosion and oxidation, superconductors, photocatalysis, wastewater treatment and electron microscopy. His group discovered a simple method to produce 'black titania' (TiO_{2-X}), which can collect energy by absorbing ultraviolet, visible and infrared radiations from sunlight, dramatically improving the efficiency of using solar energy. The nanostructure alloy/composite coatings his group developed possess superior wear and corrosion resistance, and are being used in machinery, tool and device industries in New Zealand and overseas. His selective oxidation map/theory has established the relationships of microstructure and protective oxidation, and has significant impact on oxidation-resistant coating research. He has 660 refereed research publications including 375 journal papers, 11 books and book chapters and 15 patents. He is a Fellow of the Royal Society of New Zealand and Institution of Professional Engineers in New Zealand; Vice President of the International Thin Films Society; sits on a number of editorial boards of international journals; and is Honorary/Advisory Professor for 8 universities overseas. He has also received a number of prestigious awards, including the RJ Scott Medal, James Cook Fellowship, RH Cooper Award, and Distinguished Materials Scientist of China.

Research Medal 2014

The **Research Medal** is awarded for outstanding fundamental or applied research in the physical, natural or social sciences published by a scientist under the age of 40, during the year of the award or the preceding three calendar years.

In 2014 we are pleased to award the medal jointly to two scientists.

Professor Merryn Gott, University of Auckland

Professor Merryn Gott has developed a programme of research that is at the leading edge of one of the greatest challenges facing health systems today, namely how to reduce suffering at the end of life within the context of rapidly ageing populations and constrained health budgets. Her research has resulted in over 120 publications in peer-reviewed journals as well as several books, including an international textbook for Oxford University Press which has been recognised as a ground-breaking work in its field. Not only is her work highly cited, but it has also influenced policy and led to real changes in health and social care services. Merryn directs the Te Arai Palliative Care Research Group based in the School of Nursing, University of Auckland, which has adopted a bicultural framework to focus particularly upon issues of social justice at the end of life and following bereavement. For example, she is currently leading study, funded by the Health Research Council, exploring ways of optimising care at the end of life for Māori and non-Māori over the age of 85 living in a number of communities across New Zealand. Merryn also plays a key role in supporting New Zealand's next generation of health scientists by mentoring early-career researchers and through postgraduate student supervision; she currently supervises seven PhD students.

Associate Professor Richard Tilley, Victoria University of Wellington

Associate Professor Richard Tilley of Victoria University has pioneered and developed the synthesis and electron microscopy characterisation of nanoparticles in New Zealand. The applications of the nanoparticles made in Richard's group are varied and include development, in collaboration with the Malaghan Institute and Wellington Hospital, of magnetic nanoparticles for MRI contrast agents. The contrast agents are capable of detecting tumours as small as 2 mm and will lead to earlier detection and enhanced treatment of cancers. Additional applications are making light-emitting and -absorbing quantum dots for solar cells. Richard has also unlocked new fundamental growth mechanisms to explain how nanocrystals can nucleate and grow into unique cubic, hourglass, and branched shapes with unique properties for the next generation of catalysts for greener and more efficient technologies. Richard is a Principal Investigator and runs the electron microscope facility of the MacDiarmid Institute. During the past 5 years he has published over 50 papers, including 15 in high impact factor journals, and in 2013 published by invitation in Nature Nanotechnology.

Science Communicator Award 2014

The **Science Communicator** award is made to a practising scientist for excellence in communicating science to the general public in any area of science or technology.

Dr Michelle Dickinson, University of Auckland

Having fun, getting excited, and playing around with science: this is Dr Michelle Dickinson's description of her day job as Senior Lecturer in the Department of Chemical and Materials Engineering, at the University of Auckland. She loves being able to share that passion with people from all walks of life, through her blog, public talks and TV appearances. Known as the girl who likes to break ***really*** tiny things, Michelle has a background in fracture mechanics and nanotechnology. Her passion for her discipline of materials science has been described as contagious and she is known for being able to spark that excitement in others who don't always understand the more technical details. Michelle understands that most of us don't have a PhD in science, or a mastery of the technical language that articles are written in, and believes that she can help fill the gap between the highly educated few and the public who crave for information they can understand. Michelle regularly appears on breakfast television to try to explain very complex topics in bite-sized and simple ways that anybody can understand, even before their first cup of morning coffee. As a young woman in STEM, Michelle hopes to help change the public stereotype of scientists and engineers, as well as being a role model for girls by showing that there are many fun, approachable women within this field.

The New Zealand Association of Scientists (Inc.)
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Early notice: 2015 NZAS Annual Conference

Going Public: Scientists speaking out on difficult issues

Aronui Lecture Theatre, Royal Society of New Zealand, Wellington
10 April 2015

A proposal for the creation of a Code of Public Engagement, contained within the report on MBIE's Science and Society project report 'A Nation of Curious Minds', is currently under consideration by the Royal Society of New Zealand.

Discussion of the issue in the media includes the suggestion that these changes are intended to prevent scientists from speaking out and also pointing to the current Code of Professional Standards and Ethics of the Royal Society of New Zealand, which addresses public communication in its consideration of ethical behaviour by scientists.

NZAS also referred to the concerns raised about the ability of scientists employed in our Crown research institutes to speak publically in our submission on the National Statement of Science Investment.

Despite the statutory protection of academics who accept a role as Critic and Conscience, there are concerns that funding pressures in universities can disincentivise public engagement.

Our October survey on these matters provides insights on these concerns.

See http://scientists.org.nz/blog/2014/survey-on-the-proposed-code-of-public-engagement

The 2015 conference will further explore the issues surrounding scientists speaking publically and allow members to share their experiences and suggest ways forward.

Conference details and registration will be available on www.scientists.org.nz early in January 2015.