

Sisters' winning formula

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Women produce fewer papers than men over a lifetime and are still scarce in senior positions, especially in science. Dispelling myths of innate difference between the sexes, Amanda Goodall offers advice on how they can raise their research productivity and status in the academy.

I knew nothing about the subject of women's research productivity until Grace Neville, the charismatic vice-president for teaching and learning at University College Cork, invited me to chair a seminar on the topic.

The facts are plain. Data show that men are more productive than women - male scholars publish more articles and accrue more citations over a lifetime.

Why is this? Is it the child-bearing effect leaving women less time for research? Could discrimination partly explain the difference? Or are women's brains "wired differently", making us less intellectually productive? Is it, instead, the way we do our research?

To try to get the complete picture, first we need to dispel the myth that women's brains are somehow less efficient than men's.

On 16 March 2005, I was supposed to interview Lawrence Summers, the former president of Harvard, for my research on university leaders. The interview was rescheduled. Indeed, it kept being rescheduled. This didn't surprise me. There was still a great furore over Summers' lecture at a conference on diversifying science that had taken place eight weeks earlier. I could see that an interview about leadership with a women researcher might not appeal greatly.

In his now infamous speech, Summers suggested that the dearth of women in senior science positions might be partly due to the innate brain differences between men and women. His arguments were mainly drawn from the work of Steven Pinker, an evolutionary psychologist also at Harvard. The other possible reasons Summers cited for the gender discrepancy in science included issues relating to childcare and sex discrimination.

The most powerful response to his proposition came a year later in the form of a commentary in the journal *Nature*, titled "Does gender matter?" (13 July 2006). Its author was Ben Barres, professor of neurobiology, developmental biology and neurology at Stanford University. He explained why he was motivated to write: "I became intensely interested in Summers' comments, because, as a mentor, I am intensely interested in seeing all of my students be successful in their scientific careers, including the half of my students that are women. These talented women have fulfilled their end of the social contract. They have trained and worked extremely hard. All they want is a meritocracy."

In the article, Barres uses available scientific data to shred the suggestion that women's brains are innately wired to fail at the top end of science. He challenges Pinker's work in particular: "Simply put, no one has ever found any difference between men and women in the genes or neural circuits that control their cognition."

The public response to Barres' article was profound, and in 2008 he agreed to speak on the topic at Harvard. In the lecture he delivered on 17 March of that year, he expands the arguments he made in *Nature*, all of which are based on published evidence. I cannot recommend it highly enough (you can view it online at <http://www.memdir.org/video/ben-barres-dearth-of-women-in-science.html>)

Although there isn't space here for a blow-by-blow account of his arguments and evidence, it seems important to dispel the falsehood that women may publish less than men because of innate gender differences in ability. Thus, I present the main points from Barres' Harvard lecture:

- His key message is that there are no demonstrated genetic or neurobiological cognitive differences between men and women
- He cites a number of studies showing that extreme mathematical achievement in women correlates directly with cultural gender status. Elizabeth Spelke, a psychologist at Harvard, has shown that sex differences are not present in infants. Importantly, the gap in mathematics test scores between boys and girls is shrinking rapidly
- Drawing from various gender-blind studies, he shows that gender bias and discrimination still exists to a high degree, and that this largely explains the small numbers of female scientists
- Women outperform men in real-life science problem-solving. The organisation InnoCentive.com runs a competition to find solutions to some of the toughest problems in chemistry, maths and computer science, physical and life sciences, and so on. After examining the data about who solves most problems, Karim Lakhani, an assistant professor of business administration at Harvard Business School, found that women were 3.5 times more likely to solve a problem than men
- Finally, Barres suggests that both men and women often deny gender-based bias. He thinks this is because we all have a strong desire to believe that the world is fair.

Barres is an outstanding neurologist, which gives him scientific insight into these issues. But there is another reason why he can empathise with females about discrimination: he spent the first 40 years of his life as a woman. Barres is a female-to-male transgender.

In his *Nature* article, he recalls the sexism he received when he was Barbara, a highly successful young scientist at the Massachusetts Institute of Technology: "I was the only person in a large class of nearly all men to solve a hard math problem, only to be told by the professor that my boyfriend must have solved it for me." He believes he suffered much less discrimination as a scientist when he became Ben. "Shortly after I changed sex, a faculty member was heard to say, 'Ben Barres gave a great seminar today, but then his work is much better than his sister's.'"

Barres cites numerous gender-blind studies demonstrating that the bar is raised higher for women in securing academic jobs, research grants and access to prestigious academic bodies

and prizes. About publishing, he references work showing that double-blind review increases representation of female and minority authors.

It seems that we may have confused gender identity with gender stereotyping. For example, in our house I love lipstick, and my partner loves ties (he also loves lipstick - but on me rather than on him). This identity preference does not signify that I am any less good at maths than he is (although it's true to say that I have no idea what number of lipsticks I own). The psychologist Claude Steele has shown that girls perform less well in maths tests if they are told beforehand that on average males outperform females. He refers to this as "stereotype threat". Put succinctly the other way round by the mathematician Paul Erdős: "If boys thought girls wouldn't like them if they were good at math, there would be few boys who are good at math."

I eventually got to interview Summers. Our discussion about university leaders was interesting - he went as far as to sandwich the Danish prime minister in the middle of our time together so that we could continue the interview a little longer. Summers has apologised several times for the insensitivity of his remarks about women scientists, which, arguably, may have had a negative impact on female students. On a more positive note, they certainly led to this important topic being aired and debated by some of the best brains in science.

That said, there is still much work to be done on improving the lot of women in the academy. Across the 27 countries of the European Union, 45 per cent of all PhD graduates are women. Female PhDs equal or outnumber men in all fields except the sciences and engineering, where numbers drop substantially. These figures are similar for the US.

In the EU, faculty jobs for women are vertically segregated. Women make up only 18 per cent of full professors, even though they fill 44 per cent of lecturer positions. In science and engineering, women are further under-represented; however, the proportion of female scientists is rising slowly. Alas, women still earn less than men - the average gap remains 20 per cent.

It will come as no surprise to at least half the population that bearing children seems to have a negative impact on women's research productivity over their lifetime.

Until recently, the evidence had been mixed. A number of studies show that women's publication output falls after childbirth, only to jump a little later - a factor that some speculate may be a burst of productivity prior to the arrival of child number two. Other studies demonstrate similar variation in productivity for both men and women, depending on the age of their children.

Erin Leahey, associate professor of sociology at the University of Arizona, has worked on this issue for a number of years. Her most recent paper, written with Laura Hunter, "Parenting and Research Productivity: New Evidence and Methods" (published in *Social Studies of Science*, June 2010) looks at this question in two disciplines - sociology and linguistics - using a longitudinal design. This allows the authors to study the impact of children on women's entire career. In addition to examining the quantity and flow of articles published in these two fields, the authors consider journal quality and the visibility of articles, assessed through number of citations accrued.

Leahey and Hunter find: "... the combined effects of children, gender, and time (holding all other variables constant) indicated that 18 years after having a child, a woman has an expected total of 11.54 publications, whereas her childless counterpart (man or woman) has an expected 13.32 publications." For the women in the sample, this means that by the time a child leaves home at 18, her productivity has already fallen two years behind.

The researchers also show that there is a negative hit on quality of publications and the visibility of articles published. Interestingly, in the fields of sociology and linguistics, both men and women who have children go on to publish in less prestigious journals. Both also record an immediate drop in their citations. Over a whole career, however, men's citations pick up again after children whereas women's citations run flat and remain lower than men's.

Leahey and Hunter speculate that the desire to submit to lower-tier journals may happen because of reduced self-confidence. Although anecdotal, it is common to hear from women that their confidence has dipped because of absence from work during maternity leave.

Female participation in science and technology was examined through contributions to scientific papers and patents across 14 countries by Rainer Frietsch, deputy head of the Competence Center Policy and Regions at the Fraunhofer Institute for Systems and Innovation Research ISI, and colleagues. In their resulting article ("Gender-specific patterns in patenting and publishing", *Research Policy*, May 2009), they report that Germany, Austria and Switzerland have rather low female contributions, whereas Spain, France and Italy show high female shares, while the US, Sweden, Denmark, Belgium and Australia come towards the middle.

Of particular interest in relation to the effects of children on female productivity is a scatter diagram showing a correlation between the amount of money each country invests in its pre-primary childcare system and women's scientific output. The higher the investment in childcare, the greater the number of women's publications.

One of the most enlightening papers on the subject of women's research productivity, again written by Erin Leahey and colleagues ("Gendered Academic Careers: Specializing for Success?", *Social Forces*, March 2008), identifies that women and men approach scholarship differently.

Within sociology and linguistics, Leahey found a statistically significant relationship between research productivity and the degree to which researchers specialised - which she categorises as "writing papers in the same specialty area repeatedly". Male scholars in these two disciplines tend to focus more than women.

Leahey suggests: "While attempting to demonstrate expertise, men specialize because they think a diversified research program indicates a failure to excel in any one area, whereas women diversify because they think it indicates scholarly breadth.

"In other words, women may think that diversification will broaden their professional identity, whereas men may fear it will sully theirs."

I believe this is an important finding. It is one that could account for a sizeable percentage of the difference in outputs. Leahey's finding may be particularly helpful to young women researchers who intend to have children - specialise early in your career.

In research universities, promotion is driven by the quantity and quality of one's research yield. Arguably, however, a researcher can still make an impact by producing fewer papers if they are more specialised. (I do sometimes wonder whether the world needs so many academic papers. For years, haven't we been saying that it is quality, not size, that matters?)

Academics tend to work around the clock. Teaching and administration often dominate office time, which means that much research is done in the evenings and at weekends.

The result is added pressure for those with children combined with the often-raised issue of the "double shift" (that is, women in effect doing a second job at home as they carry out domestic duties).

Being overloaded by administration and other departmental responsibilities is a common complaint. I would argue that the recent culture of managerialism has led to an increase in paperwork for everyone.

Two women I know, who have since left their universities, used to complain to me about having heads of department who were not interested in research, only in teaching. Although the women were lecturer grade, they were allocated no time for research. Both complained about double standards in their heads' treatment of young males compared with females, the former being given lighter loads. Interestingly, both the department chairs were women.

I have observed that one of the key problems for women is their reluctance to self-promote (made worse if they are also British!). To anyone doing research, nothing is more important than getting your findings out to the world. Promoting one's work raises its visibility and impact. Men seem to have less difficulty doing this. At the same time, although women are natural networkers, we may not be exploiting this facility in research terms.

For this article, I asked Erin Leahey what key piece of advice she would pass on to young women researchers, and what changes she felt universities could make to better support women doing research.

"My recent paper with Laura Hunter shows that among parents, women's productivity rate suffers more than men's. My earlier research suggests that specialising is beneficial, especially for productivity, which in turn affects visibility and earnings. So, for at least the initial stage of their career, women should focus on constructing a succinct intellectual identity through their publications.

"My findings also suggest that women's visibility, in particular, is cumulative, so helping women embed themselves in scholarly communities early in their careers should ameliorate gender inequality in academe."

As to the question of what universities can do, she said: "Institutional efforts - such as on-site childcare, not overloading women with administration, mentoring faculty, fostering collaboration and providing information about journals, peer-review processes and grants - will help women academics with and without young children to maintain their productivity."

Stanford now offers a Junior Faculty Child Care Assistance Programme for parents with children aged five and under (thanks largely to the initial efforts of Ben Barres).

So where does all this leave us? Importantly, we know from the data that women are as capable as men at the top end of academic creativity. After all, the first person to receive two Nobel prizes was a woman - Marie Curie was awarded the Nobel Prize in Physics in 1903 and Chemistry in 1911. That we are intellectually equal should surprise no one.

Nevertheless, the actions and behaviours of some in academe suggest that not everybody knows this fact - which, of course, produces the discrimination that reduces the power and expression of women, among others.

I will close with a list of suggestions from those who attended my seminar in Ireland and from other colleagues and friends I have spoken with.

Some may wonder why these pages should be devoted to trying to minimise the gender gap in research productivity when there are so many other more important issues facing women around the world. As a meritocratist, it is my belief that the position of women everywhere is improved when the position of women somewhere is improved.

With regard to women and their research, I will leave you with a note I received from a pro vice-chancellor about her summer break: "I've been having a great time - sun, sea and good research - what more could a woman want...".

TIPS FOR ENSURING SUCCESS

- ✓ Maintain a focused research agenda, at least in the early years of your career.
- ✓ Put quality before quantity - produce fewer but better papers.
- ✓ Submit to the best journals, and keep on doing so. Accept the pain of rejection letters, and don't take it personally.
- ✓ "Eighty per cent of success is just showing up" (Woody Allen). Be seen and be heard. Be as loud as men are in seminars. Self-promote. Be visible and make your papers accessible. Build a website with all your work downloadable. Include a photo.
- ✓ Don't feel that you have no option but to stay at a place where the conditions are not conducive, or are even unhelpful, to your research. If it is difficult to move, don't let that be known.
- ✓ Do less plutzing - don't beat yourself up about the things you are not so great at. Join forces with co-authors who complement your own skill set if necessary.
- ✓ Network. Women are great networkers. The returns on networking in academe are high, in terms of generating both co-authors and research visibility. Spread the networks wide.
- ✓ Speak out when things are not right, particularly if you are a senior woman academic. It may be uncomfortable for us to raise these issues, especially in a mostly male environment, but if we don't ask, we don't get.

- ✓ Ensure that committees are heterogeneous. It is shocking how common all-male committees are still. People are more likely to hire or give grants to others who are like themselves. The evidence shows that a panel of men is more likely to select another man.
- ✓ Outsource. A brain surgeon, interviewed on the radio, said she realised early on that to develop her career she would have to outsource as many domestic duties as possible (by hiring cleaners, employing childcare and so on), right up to the maximum she and her husband could afford. Buy in help, and do what you are good at. It may seem expensive, but the long-run returns are high.
- ✓ Ask for more. Women receive an average of 20 per cent less pay than men. Some of this will be because we never ask for a pay rise! A TV producer friend gets very frustrated when the women she interviews ask for considerably less pay than the men, even when they are better qualified for the job than the men.
- ✓ If you are a senior woman, help your junior peers. Ben Barres suggests that senior women scientists aren't always as helpful as one might expect to other women. Just because you did it your way doesn't mean that's the only way.
- ✓ Barres said it is important for women scientists to find a mentor, but he advised not to choose a woman just because you are one yourself. Find the right person.
- ✓ We need more women leaders. On average throughout the 27 EU countries, only 13 per cent of institutions in higher education are headed by women, and only 9 per cent of universities have a female head.
- ✓ If you are a leader, find out how happy your women workers are. Happiness is shown to correlate highly with productivity.