"The problem that won't go away": Femininity, motherhood and science

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Abstract

Despite second wave feminist campaigns like 'Girls can do anything' women scientists still find that juggling career expectations with family responsibilities presents a major barrier to their full participation. History shows that scientific values and culture have been created by and for men and that women and minority groups are expected to fit in with pre-existing norms; separation of personal and professional lives should be maintained. Drawing on auto/biographies, a review of feminist science studies literature and oral history interviews with women scientists in Aotearoa/ New Zealand this paper shows that femininity and science have invariably been viewed as mutually exclusive and that the 'two body problem' is one that just 'won't go away'. Interviews reveal that women who 'succeed' as scientists are either childfree or have someone who is prepared to share family responsibilities. For most women in science, and increasingly men too, there is a continual challenge between balancing quality of life with career success. Obsolete gender norms are now commonly rejected by involved mothers and fathers, both of whom crave family-friendly policies that do not penalize them for 'doing too much childcare'. Mentoring, leadership programmes, affirmative action and work/family balance have limited utility. If true equity is to be achieved, then fathers need to share family responsibilities equally and the culture of science must change to accommodate diversity. The spotlight needs to be removed from women and focused instead on transforming science culture.

Since second wave feminism there has been an increase in the numbers of women studying and working in science, technology, engineering, medicine and mathematics in Western societies.[1] Campaigns like 'Girls can do anything' have contributed successfully to challenging the notion that there is some biological foundation for the under-representation of females in certain areas of society. Nevertheless, research shows that when asked to draw a picture of a scientist children invariably produce an image of a male, wearing a white coat and a beard and usually accompanied by some scientific equipment (Schiebinger, 1993:73).[2]

The widespread perception that scientists are male, that there is no place for women in science,[3] and that women do not have the aptitude for it persists, at least in the west.[4] To some extent this is because these myths have a long history. A scientist, unless qualified otherwise, is presumed to be male.[5] New Zealand's own Ernest Rutherford, on meeting chemist Lise Meitner for the first time, is reported to have said: "Oh I thought you were a man" (Rife, 1998:36)[6], while astronomer Edwin Hubble described astrophysicist Cecilia Payne-Gaposchkin as "the best man at Harvard" (Haramundanis, 1996:184).[7]

In Aotearoa/New Zealand Ella Campbell described how, as the only woman scientist at Massey University in the 1940s, she used to be taken for the Matron if she went out anywhere (OHInt0624-1). Some years later, at the University of Michigan, she was told that, as a female, she was 'lucky' to be there as women were not welcome. Confronting such attitudes was a common experience:

> The energy required to battle against these attitudes was a very exhausting thing…a very draining thing. [You were] always being battered with this business that you shouldn't be there, that you had no business being there'.

Some progress in the last 50 years is evident – in some disciplines women undergraduates now

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outnumber men – so one could be forgiven for thinking that the male stereotype of a scientist is now a relic of our past.[8] However, changes have been sporadic; there has not been a steady march of progress.[9] Although in some disciplines and locations women scientists feel respected and supported, others feel subject to discrimination and/or sexism (Shields, 2010).[10]

The more prestigious the institution the more conservative it may be. In 2005, Larry Summers, now former President of Harvard University, exemplified the view that women do not have an innate ability for science. He claimed that one of the reasons for the "very substantial disparities between the percentage of women among tenured professors of science" was what he labelled "different availability of aptitude at the high end" (Dean, 2006). The furore created by his speech was immediate (Ceci and Williams cited first in Monosson, 2008:12), and ultimately led to his departure.[11]

Because of the high levels of commitment that are pre-requisites for success in science (Ginorio, 2001:24), women scientists with children often find it difficult to strike the right balance between meeting the expectations of a scientific career with those of motherhood. Trying to keep all their balls in the air as they attempt to juggle the often conflicting requirements of work and family, is frequently stressful.[12] Life/work balance is not a problem specific to science alone. However, international studies insist that scientific work is particularly characterised by "long working hours, frequent travel, field trips, little support for those with caring responsibilities, competition and individualistic values, sexual harassment, bullying, and social activities which do not appeal to female colleagues" (Phipps, 2008:149). Consequently, retention is an ongoing problem.

Many current arguments for recruiting women (and members of minority groups) into, or back to, science seems instrumentally based on economic concerns rather than a commitment to equity. For example, the Royal Society in Aotearoa/New Zealand claims that retaining women long term in scientific careers "would increase the numbers of highly qualified people able to contribute to the economy" (Logan and Sutherland, 2005). While it acknowledges the tension between work and family responsibilities, the Royal Society's emphasis appears geared more towards equal opportunity than affirmative action policies.[13] Alison Phipps (2008:142) argues that the former strategy is insufficient if change is to eventuate, and, in times of recession work-life balance or flexible working policies are likely to be forgotten altogether (Bagilhole et al, 2008:29).

The use of a business case approach is problematic. It implies that women scientists are a reserve army of labour, a 'last resort' (Henwood cited first in Bagilhole et al, 2008:15). Kathleen Lonsdale, one of the first women elected to the Royal Society in London, is one scientist who would probably endorse a more pro-active approach. Forty years ago she posed the following question:

> Is it Utopian to suggest that any country that really wants married women to return to a scientific career when her children no longer need her physical presence should make special arrangements that encourage her to do so (Monosson, 2008:14).

This article will consider what structural arrangements might address the 'two body problem' of balancing family responsibilities with a scientific career. Understanding the roots of women's exclusion contributes to problem-solving. Working in science today means compliance with values and systems that were established historically for men, and not women.[14] Therefore, what follows are auto/biographical examples that exemplify how, traditionally, the perception of science as masculine and the experience of motherhood have served as barriers to women's full participation. The paper is informed by a review of the now extensive literature about women in science and feminist science studies. It also draws on oral history interviews

with women scientists in Aotearoa/New Zealand.

Lessons from History

The structural exclusion of women from science can be traced back to at least the 18th century. One of the results of the ideological public/private split that evolved out of Enlightenment thinking and liberal political theory was that women were confined to the domestic sphere while science, as part of the public sphere, became a male domain. Despite feminist foremother Mary Wollstonecraft's powerful arguments to the contrary, women were deemed incapable of reason and were largely excluded from education. Of course there were exceptions such as Wollstonecraft herself and, more pertinently for this discussion, scientists such as Mary Somerville,[15] Margaret Cavendish,[16] and French aristocrat Emilie, Marquise du Chatelet.

Du Chatelet was privileged because she was educated, wealthy, of high status, had access to scientific resources and, like Cavendish, socialized with scientists who were prepared to share their knowledge. However, despite these benefits, she was still disadvantaged in participating in science as fully as she would have liked because of her gender. For example, she was unable to publish under her own name or be a member of the Academie of Sciences, the French equivalent of the Royal Society of London.

Tradition prescribed that, as a wife and mother, she should conform to society's expectations of managing her children and her household. Her scientific work, a challenge to gendered social norms, was something she had to fit around her family responsibilities and she found this frustrating:

> There's so much to do when you have a family, and a house to run…so many unimportant details and obligations, that I barely get any time to read new books. I give up at how ignorant I am. If I were a man…I'd just get rid of all the useless things of my life (Bodanis, 2006:125).

Domestic responsibilities notwithstanding, du Chatelet was instrumental in bringing Newtonian ideas to the French public and she translated and annotated Newton's *Principia*, still the only complete version available in French. The resulting book was a much clearer exposition of Newton's ideas than the original. Newton was the Einstein of his day; his work was intelligible only to a few and du Chatelet's scientific contribution should be judged accordingly.

Many conventional biographies of women tend to focus on their association with famous or powerful men and du Chatelet is, arguably, better known today for being Voltaire's mistress rather than as a scientist (ibid).[17] He, however, described her as a "great and powerful genius, the Minerva of France", a "great man whose only fault was being a woman."

Maria Goeppert-Mayer was the third woman ever to be awarded a Nobel Prize. After her marriage to physical chemist Joseph E. Mayer in 1930, and the birth of two children, she continued her scientific career. However, according to the Nobel Laureate herself, being a married woman physicist at that time was "nearly impossible" (Schiebinger, 1999:100). Goeppert-Mayer became a "volunteer associate" in her husband's laboratory, first at John Hopkins University and then the University of Chicago, for 29 years (Shepherd, 1993:42-43). At John Hopkins she had an attic office; a mixed assortment of honorary job titles; taught classes; wrote papers that are still quoted in journals today, and a textbook. And she did all this, unpaid,[18] while still caring for her two children and her household. Although, like du Chatelet, she was in many ways privileged, with the support of her family and many notable scientists, she did not secure full-time work in her field until she was 53.

In Chicago Goeppert-Mayer published papers that remain "classics in the field" and did the research that led to her Nobel Prize in Physics. When her achievement was announced in 1963 her unpaid domestic role was foregrounded over her then paid work as a scientist. The headline

in her local San Diego newspaper proclaimed: "SD mother wins Nobel prize".

This is a typical example of women scientists being judged by different criteria than men. While we might all dream of a time when women are duly recognised for their unpaid caring roles, the point here is that it was Goeppert-Mayer's work as a scientist that led to her becoming a Nobel Laureate. It was a significant achievement for anyone, but particularly for a woman who had struggled against the odds just to continue to do the science she loved. Can you imagine the archetypical scientist Albert Einstein's achievement being treated similarly: "Berlin father wins Nobel Prize"? Turning the tables like this highlights the absurdity and sexism of the newspaper headline. Women's success in the public sphere is all too often minimised and subordinated to their domestic roles while men's paid work remains central to their identity.[19]

Beatrice Hill Tinsley was educated at New Plymouth Girls' High School and the University of Canterbury. She has been variously described by students and colleagues as a giant of astronomy, the outstanding woman scientist of her age, a genius, and a pioneer of modern cosmology. However, until recently she has been largely unknown in Aotearoa/New Zealand. If, as her biographer, Christine Cole Catley, suggests, Tinsley is as important as Ernest Rutherford and for Michael King, is one of New Zealand's 'great stories', how can we account for the near invisibility of someone "whom nobody, anywhere could forget" who was also "the greatest New Zealand astronomer never known"? Why do many descriptions of her conclude that she was a good scientist but a bad mother?

Scientific standards should be neutral and ungendered, particularly because scientists generally stress the need for objectivity in research. However, as discussed previously, with women the spotlight frequently focuses on their roles as wives and mothers to the exclusion or dilution of other achievements. Traditionally, men's private lives, if they are discussed at all, are treated as secondary to their achievements.[20] Not so Beatrice:

> To make time for her scientific career, Beatrice had an abortion, divorced herself from her husband and left the children in his care. Though she tried to put these events behind her, her inner distress was to torment her for the rest of her life (Brockie cited first in Hall, 2006).

Without doubt this was a difficult time for Tinsley but her decisions to have an abortion and, later, to leave her two children in the care of their father were far more complex than this explanation leads us to believe, and the suggestion that they were motivated by career aspirations alone is highly speculative.[21] The description of her "torment" is an emotive and gendered one; it reinforces the view of women as more emotional or mentally unstable than men. This focus on Tinsley's personal life (and the example of Geppert-Mayer above) reinforces the claim that this is typical when women scientists are the focus of discussion. However, it is rare when men are the subjects whether or not, like Tinsley, their actions defy societal expectations. Einstein behaved callously when he deserted both his first wife and his two sons. The fact that he is not condemned for poor treatment of his family, when women like Tinsley are, emphasises how both biographers, and scientists, may be gendered in their analysis.[22]

The Oral History Project

My ongoing oral history project examines the position of women and gender relations in science in Aotearoa/New Zealand. I am not a scientist myself but I convene a feminist science studies course in Gender and Women's Studies at Victoria University of Wellington. My aim is to investigate how Aotearoa/New Zealand compares with overseas studies. Oral history is a powerful research tool for allowing narrators to not only talk about 'facts', with which scientists are mostly concerned, but also to talk about their feelings.

Science is commonly believed to be "cold, straight and detached" (Felt, 2009:21), and the

researcher incidental to the findings. However, despite the myth that scientists are objective and base decisions on merit, there is an impressive body of controlled experimental studies and examination of decision-making processes that demonstrate otherwise. A 2006 report carried out in the US by the Committee on Maximizing the Potential of Women in Academic Science and Engineering argued that, on average, people are less likely to hire a woman than a man with identical qualifications, are less likely to ascribe credit to a woman than a man for identical accomplishments, and, when information is scarce, will far more often give the benefit of the doubt to a man than a woman. Although most scientists intend to be fair, research shows that in practice they often are not.[23]

Much of the information we have about women in science in New Zealand consists of statistical data – how many women work where. Oral history and feminist methodology is more interested in stories of subjective experiences and how people construct identities, memories and meaning. If equitable treatment of women in science is to occur and barriers to their full participation removed, then both stories and statistics need to be collected:

> Clearly you need both…Data has to go together with individual women's experiences. Sometimes that's not easy for people to hear, and sometimes that's not believed the first time round (Massachussets Institute of Technology, 2001).

This underlines the concern many scientists have with qualitative or 'subjective' research. Recognition of the feminist claim that experience is a valid form of data is not always accepted in a scientific community that is generally more comfortable with facts and figures. Ulrike Felt offers a possible explanation: "Numbers somehow hide the traces of human production; they convey the feeling of being an objective, value-free description of reality" (2009:30). More importantly, they pose less of a threat; the quality of women's experiences is more challenging of the status quo (Bagilhole et al, 2008:6).

Engaging in and publishing qualitative research in this area is a risky business for both researcher and participants:

> [I]ncluding emotional aspects of a woman's life will reinforce all those existing prejudices that women do not belong in the cold world of scientific research (Fara, 2004:21).

In other words, discussing and/or writing about the difficulties many women scientists experience may actually exacerbate them. Linda Shepherd (1993:5) claims that women scientists dare not talk about differences between the sexes and try to convince others that differences do not exist. The impact of motherhood on scientific careers was something that Emily Monosson's participants were also reluctant to discuss for fear that it would 'weaken their professional standing and future career options', or that they would be accused of 'whining' (2008:9).

Although increasing numbers of women are entering science, research shows that women exit at various educational or career transitions, for example from undergraduate to postgraduate study or postgraduate to postdoctoral positions. This problem is referred to as the 'leaky pipeline' and, as referred to above, there is much international discussion of how to stem the outward flow and recruit more women (and members of minority groups) into, or back to, science.[24] Lack of women in particular areas of science is often portrayed as an individual problem. This is commonly referred to as the deficit model – the concept that the root of the problem is women themselves (Wajcman, 1991). The difficulty with this is that the spotlight remains on women while the culture of science itself remains hidden and is not subject to challenge or analysis.

I agree with other researchers in this area that what is defined as science needs to be broadened (Mayberry, 2001; Monosson, 2008). I interviewed academic scientists throughout the country, at various stages of their careers, from diverse disciplines including the so-called hard

sciences, but not exclusively so. Scientists from science-related government institutions and non-government organizations were also approached. Not all those I interviewed were research scientists, what some people label 'real' scientists;[25] some were involved in various ways in the public dissemination of science such as in museums.

The response rate of narrators has been extremely encouraging. This suggests to me that the topic of research is timely and evidence suggests that just having a chance to talk about these issues is valuable. However, the willingness to participate and share experiences has been moderated by concerns about confidentiality.[26] Several have mentioned, usually after the first interview, that as one of few women scientists in their field they might be easily identifiable if information is not handled carefully by omitting their discipline, workplace or other information that might make them easily recognizible. These scientists' fears of being labelled negatively are probably well-founded. Consequently, identifiable information has been excluded.

Although many women scientists feel they need to downplay difficult aspects of their experiences if they are to succeed in their careers, in order to tackle a problem one first has to identify and describe it. My hope is that rather than detracting from the triumphs women scientists have achieved, highlighting these issues will reveal how hard-earned success has actually been. I now turn to two inter-related concerns: the masculine culture of science and motherhood.

Scientist=Man/Woman=Non-Scientist: Masculinity, femininity and science

Most narrators identify as a scientist rather than a woman scientist. Although, like 'doctor', the term 'scientist' is theoretically generic, unless it is qualified it is commonly assumed to be referring to a male.[27] British research shows that "the model for a scientist is a man" and that women strive to be good scientists by being non-women "at the same time as they are very aware of their womanhood" (Bagilhole et al, 2007:28). The denial of the importance of gender is predictable given that the terms 'feminine' and 'science' have often been seen as mutually exclusive (Shepherd, 1993:5). One European woman working in IT claims that women have to be asexual in order to succeed in their careers (Bagilhole et al, 2007:28).

Trying to balance being a consummate professional and a woman is problematic: "[To] make it as a female scientist, you have to make it as a scientist and truly downplay the female" (Wyer, 2001:84), and, I would add, the maternal. The qualities and expectations associated with being a scientist are those normally associated with men: being rational, competitive, [28] totally committed, not distracted by family and personal life, and always available. Unsurprisingly, in an environment in which organizational definitions of competence and leadership are still predicated on traits stereotypically associated with men (Meyerson and Fletcher, 2003), some women scientists assimilate to this male model.[29] Furthermore, some women feel that compliance with workplace norms and displaying behaviour typically associated with men is necessary to avoid "stereotypical performance expectations that are based on one's sex" (Bagilhole et al, 2008:20). However, as James Watson's reproach of Rosalind Franklin shows,[30] this strategy can sometimes backfire as women can be penalized for not being womanly enough:

> By choice she did not emphasise her feminine qualities. Though her features were strong, she was not unattractive and might have been quite stunning had she taken even a mild interest in clothes. This she did not. There was never lipstick to contrast with her straight black hair (Maddox, 2003).

Had she been more 'feminine' she might not have stood her ground as firmly as she did and so be depicted (unfairly and subjectively) by Watson as a belligerent, bad-tempered blue stocking who hoarded her data (ibid). Nobel Laureate Barbara McLintock's biographer reinforces the view that denial of femininity may be a useful survival mechanism in science. According

to Evelyn Fox Keller (1992:50), McLintock "devoted her life to a repudiation of all feminine stereotypes", and claims that this denial may have been necessary to her survival as a scientist.

Adopting the male model and shedding "the trappings of femininity" are necessary if a woman is to be taken seriously as a scientist (Schiebinger, 1999:76). Indeed one narrator advises her women students pursuing a career in science to learn to play the game and "behave as much like a boy as you can". Although this particular narrator is consciously aware and selective of when her gender performance is 'male' other narratives reinforce the claim that "recognition and understanding of the gendered cultures of SET organizations is actually low or absent in women themselves" (Bagilhole et al, 2008:5). This may account for why several narrators insist that they work long hours, not because they are expected to, but from personal choice.

'Choice' is a common catch-cry, especially of third wave feminists. However, often when we think our decisions are autonomous we are in fact responding to the expectations of others and in science it is common for scientists to work 60 to 80 hours and often seven days a week. Some narrators said that they work long hours because they love what they do and it is clear that with few exceptions narrators demonstrate a passion for their science. Nevertheless several acknowledge that their example is not necessarily a positive one for students and other staff, male or female, who may perceive their long working hours as 'unbalanced'. One narrator confessed that not many women would view her as a good role model. Moreover she recognizes that her ability or choice to work long hours is facilitated by the fact that she has no childcare responsibilities.

In my view women scientists are stuck between a rock and a hard place. On the one hand they are encouraged to be one of the boys; on the other some 'boy's' qualities are discouraged in women. Interviewed in the 1990s Lady Peggy Fleming, wife (and unpaid assistant) of Sir Charles Fleming,[31] discouraged young women from behaving aggressively as "men are scared of women like that". She advocated use of perceived 'feminine' qualities by advising young women to be more diplomatic when handling men so that they do not feel that "they're being put down". She also implied that maternal qualities are also useful in handling men who, she claimed, behave "like children."

But here's the rub. If women perform the stereotypically masculine role of a scientist, they, like Rosalind Franklin, may be viewed as not feminine enough. If they perform the stereotypically feminine role of a 'woman' by, for example, adopting nurturing behaviour or wearing 'feminine' clothing,[32] they risk being judged as not professional enough. Furthermore, it should not be forgotten that the binary opposition of masculinity and femininity subordinates the latter to the former; 'feminine' qualities or values are deemed inferior.

Scientists are representative of the society to which they belong and are not immune from gender (and other) stereotyping. The stereotypical assumptions some scientists, male or female, hold may result in women being accused of unfeminine behaviour in the workplace:

> Because people judge others in terms of …unconscious prejudices…the same behaviour that would suggest a man is collaborative, judicious or flexible would mark a woman as needy, timid or flighty….a woman who succeeds [in science] may be viewed as 'selfish, manipulative, bitter, untrustworthy, conniving and cold' (Heilman cited first in Dean, 2006).

The reaction of some parents reinforces the contention that the masculine image of science and technology jars with prevailing stereotypes of femininity (Phipps, 2008:46). Some expressed concern about the impact of science on their daughters' futures. One narrator's father cautioned that her chosen career was not "a proper girl's job". Another was alarmed that his

daughter's career might get in the way of her "getting married". Parental aspirations reinforce cultural expectations of appropriate jobs for women. I now turn to the occupation most feminists label compulsory for women, motherhood.

Motherhood

Many women persist in their pursuit of scientific careers despite severe conflicts between work pressure and family responsibilities. However, the determination many exercise in managing the struggle is often not recognized as epitomizing the high level of dedication to their careers they represent (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2006). Motherhood, it could be argued, is the ultimate expression of femininity so what is the career cost of motherhood for women scientists, some of whom claim that gender is irrelevant in the workplace?

Although mothers are commonly perceived as a problem in science, non-mothers may be conceptualised as a risk (Devine cited first in Bagilhole et al, 2008:29). Furthermore, many scientists consider it perfectly reasonable to take account of family responsibilities when evaluating colleagues, regardless of their demonstrated achievement (Eskowitz cited in Bagilhole et al, 2008:29). To pre-empt criticism and the accusation that choosing motherhood means that they are not taking their science seriously,[33] some go to great lengths to ensure that children do not, or do not appear to, interfere with their work. More women than men practice behaviours that tend to "minimise, hide, or neglect family commitments in order to improve work performance or to maintain the appearance of the ideal worker, with varying degrees of success" (Monosson, 2008:19). As a result of the prevalent attitude that science and children do not mix,[34] some women scientists choose not to have children at all or have only one; others postpone motherhood until the timing is 'right'. There is a price to pay for choosing motherhood:

> Although we are now more conscious about equal opportunities I think there are still a number of inbuilt structural disadvantages for women. I am very conscious that having worked part-time, having had a rather disrupted career, my research record is a good deal patchier than any man's of a comparable age…The life experience of a woman is rather different from that of the male…

The comment above was made in 1996 by astrophysicist and overlooked Nobel Prize winner,[35] Jocelyn Bell Burnell. An advocate for women in science, she has been critical of the male standard that is a feature of physics and astronomy.

Some narrators insist that their career, though significant, is less important than family and, if a choice between the two were necessary, science would lose out. Motherhood has impacted on their careers to the extent that publishing and attending overseas conferences has proved more difficult. Research and study leave away from New Zealand is hard if it involves disturbing children's schooling. One narrator claims that women scientists who have done well professionally often have no children, leave motherhood until later, or have partners who share or undertake most of the childcare:

> I think it's very difficult for any woman academic to have a career, with children, unless there is a supportive partner, or a supportive mother or mother-in-law who can help. You need at least one person who is willing to sacrifice essentially their own life so that you can have yours.

Traditionally, certainly in heterosexual relationships, it has been women who have sacrificed their career aspirations in order to prioritize those of their partner. Many of the problems discussed above occur in non-scientific research and academia as well as other professions. However, these are intensified by the demands of working as a research scientist, whether in the laboratory or in the field.

As mentioned previously, women's emotional involvements are often considered a sign of intellectual inferiority (Ahrianrhod, 1993:47) and because the culture of science is male, superiors often do not take personal circumstances into account. One narrator said that most women do not take the parental leave they are entitled to; others were denied the maternity leave they applied for. Most mothers interviewed had continued to work in some capacity throughout their maternity leave – supervising PhD students, marking or continuing research. Many were advised to write papers while on maternity leave, highlighting the lack of understanding of or accommodation for the time and energy involved in birthing and caring for children.

One narrator who frequently works a seven day week acknowledges that the long hours she puts in would be impossible if she had children.

> There are women professors who manage very, very well with what's seen to be a far more balanced lifestyle than mine. But I think it's probably fairly common knowledge that most of the women professors in science in our university don't have big family responsibilities and, you know, have chosen to devote a very large proportion of their life to their careers.[36]

When asked if some women scientists have consciously chosen not to have children she said:

> I would say yes. It's too difficult, too difficult to manage. They don't have the strength quite frankly to manage juggling the responsibilities of children with their career. Others have managed it but they tend to have a very strong support person or persons in the background to help with the management of that.

There is preliminary evidence to suggest that Crown Research Institutes (CRI) may be more accommodating of the realities of women scientists' lives than universities.[37] The following extract is from someone who was pregnant when she commenced employment at a CRI. Her experience there was a positive one:

> I've heard a lot of stories of a lot of women in science who've had children and not had that experience and not had that support. A woman recently, she took a year's maternity leave, she had been quite senior, and when she got back she had been restructured out of existence and was offered two jobs neither of which were senior. I don't think that's unusual. I think I was lucky.

In response to my follow-up question as to whether childcare was provided she added: "No childcare but very family friendly, not minding if I needed to be at home; letting me work at home, letting me work flexible hours". She later became an academic and I asked how CRIs and universities compared:

> Academia's not so supportive. Again I think it depends on your immediate working environment….I didn't have any babies while I've been on the staff here but my understanding is it is not so supportive. Lots of women are told they should make sure they write lots of papers while they're on maternity leave. Much more of a pressure to keep performing, keep the output up, and keep working, rather than actually spend any quality time with your child.

This suggests that personal lives and circumstances are not expected to intrude on scientists' work. The example of someone who was re-structured out serves as a cautionary tale to all women if they wish to retain their jobs.

Given the difficulty of combining motherhood with scientific careers I asked narrators what they considered the best time to have a child, optimum in terms of causing least disruption. A number suggested that during doctoral study was ideal (others disagreed) because it is the only time when a scientist can give all their attention to their research. The long, linear career path of scientists consists of BSc, Masters, PhD, Post-doc and then a research job somewhere, by which time most are in their 30s and heeding biological clocks. However, a number did emphasise that there are positive spinoffs from being a mother:

> [T]here is a life you know; there is a life with babies. And if anything it gives women this experience of actu-

> ally – their time management experience is so much greater when they know that there are certain things they have to stop for…. So I think having babies does allow women, because it does tend to be women…to be able to compartmentalize their life a bit and get off this rollercoaster for a small period of time.

This view was shared by most mothers interviewed. Although it could be argued that narrators are trying to put a positive spin on a difficult experience, in talking of the benefits of being a mother and a scientist – learning to manage one's time better, having a more rounded life, being more focused – that was not the case in this instance. In my view this particular narrator was very frank in discussing the pros and cons of balancing motherhood and science.

A number of narrators insist that the two body problem is not women's alone, reinforcing the view that outdated gender norms repulse young men and women alike (Felt, 2009:241). Many younger scientist fathers want to be more involved parents than many of their predecessors but may also be "treated inappropriately" if they prioritise family over work. Nevertheless, mothers continue to shoulder the major burden for what society still perceives as women's responsibility for children, the sick and the elderly, and scientific culture has been built on the expectation that scientists have spousal support (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2006).[38]

Science today is a more demanding taskmaster than when some narrators first became mothers:

> And what I see these days is that young women, because the pressure; in those days we didn't have email, didn't even have computers. So the pressure now from the constant emails…means that for senior people it is constant and I think for the junior people it is much more pressured…the pressure, I think the pressure now is worse than it was, so I think in those days (when you were doing your PhD) it was quite a good time to have children, but from the point of view of your PhD supervisor…

The last point indicates the potential conflict that may follow a supervisor becoming aware of a forthcoming pregnancy. Also in the current PBRF environment,[39] when PhD completions have become so much more important than they were previously, such an announcement might be greeted with even more alarm than it was previously. The increased pressure to produce research outputs and attract funding exacerbates the problem of balancing public and private lives.

The culture of the scientific workplace

Various strategies have been utilized in the last few decades with a view to improving the position of women in science: encouraging more girls/women to take up science with a view to producing a critical mass and therefore a more woman-friendly environment; mentoring and leadership programmes to help women cope with the "chilly climate" of science; women only support groups; more flexible working practices and so on. Despite these approaches, Susan Molyneux-Hodgson claims that it is difficult to see what has changed in the gendered distribution and character of scientific work (2009:i).

A number of feminist science scholars claim that women remain outsiders in scientific culture (Wyer et al, 2001:20), and that increasing the number of women and other minorities in science without a change in the structure [and culture] of the scientific workplace does not decrease gender disparity significantly (Sulmun, 2001:219). Annette Williams, Director of the UK Resource Centre for Women in Science, argues that the science and technology professions have been built "by men, for men" and that they are so androcentric that they lag behind other sectors (cited first in Shields, 2010). Similarly, men's domination of management and decision-making positions enables men to "set agendas, define working practices and shape workplace cultures" in ways that do not take women scientists' life experiences into account (Phipps,

2008:148): "Displays of masculinity often get conflated with images of working, in a way that hurts many women, some men and the work" (Ely et al, 2003). Rules that appear quite neutral may function in a way that leads to differential treatment or produce differential outcomes for men and women (Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2006).

Some of the difficulties narrators would like addressed by employers and colleagues are childcare provision, lack of flexibility, recognition of family lives, 'real' part-time work that does not result in a negative career outcome, and adjustment of the demands of a scientific career that ensure incompatibility between work and family life. Family responsibilities lead to problems meeting employer expectations unless suitable arrangements for children can be made. Those narrators who are married to other scientists or academics in effect become solo mothers when their partners go overseas for conferences or sabbaticals.[40] Most male scientists who are fathers are not under the same pressure to put children before career because of the presumption that mothers are the primary carers.

Narrators argue that more family-friendly workplaces would benefit men and women, let alone students who would benefit from role models of scientists who are also actively involved parents. Fathers who want to share family responsibilities are disadvantaged. Like women, they "get hostility for doing too much childcare". International research refers to this as the "daddy penalty" (Schiebinger, 1999:98). Choosing to spend time with family rather than working has real consequences for males *and* females (Davis cited first in Bagilhole et al, 2008:28).

One narrator claims that only a woman scientist who has met the required standards would have any hope of trying to change science culture. However, this strategy was not one raised frequently even though this has been identified by feminist science studies scholars as the best tactic for tackling many of the problems experienced. How might science change to accommodate diversity if many shy away from policies and processes designed to change the internal culture of the science departments women will be entering? I have found the recent work of organizational theorists Ely et al instructive here. They suggest that shifting the focus from the notion of gender as a women's issue and instead treating gender as "a central organizing feature of social life, with implications for women, men and how we get work done…" seems a more sensible, if somewhat challenging, strategy (Ely et al, 2003:3). This is analogous to promoting gender analysis as an integral part of science policy and practice (Ministry of Women's Affairs, 1996). Ely et al (2003:5) suggest that, to date, the problem of gender differences in the workplace has been tackled using four frames: fixing women; celebrating differences; creating equal opportunities; and finally, revising the work culture. While all have benefits and limitations they, like feminist science studies scholars, claim that changing the culture may have most to offer.

"Fixing the women" has been the most common approach and is related to a liberal, individualistic, merit-based agenda: women are just like men. This framework promotes strategies such as leadership and mentoring schemes to help women overcome their socialization and learn how to play the game. Although this has helped individual women to succeed it fails to challenge the masculine culture of science and, as Phipps argues, there is a need to shift the focus from helping women to cope with scientific workplaces and "towards more ambitious demands for reforming these environments and reshaping the patriarchal organization of public and private life" (2008:46).

"Celebrating differences" involves valuing women's previously unrecognized skills and emphasizing the positive contribution women bring to an organization. For example, lawyer Brigid McArthur (2010) has recently cited research that claims that when businesses recruit,

train and promote women they make better and more innovative decisions, produce better products and ultimately attain better financial results than more traditional firms. Equality and difference arguments have a long history but both are problematic:

> [E]quality cannot be achieved by allowing men to build social institutions according to their interests, and then ignoring the gender of the candidates when deciding who fills the roles in these institutions. The problem is that the roles may be defined in such a way as to make men more suited to them, even under gender-neutral competition….The difference approach [to gender equality] insists that gender should not be taken into account in deciding who should have a job, but it ignores the fact that day one of taking gender into account was the day the job was structured with the expectation that its occupant would have no child-care responsibilities (Kymlicka cited first in Eisenhart et al, 1990:241).

The creation of equal opportunities focuses on removing barriers to women's participation and eliminating biases. Affirmative action policies are one example of this strategy; another is work-family policies. The Ministry of Women's Affairs claims that improvements in work-life balance achieve economic and social benefits for men, women, families/whānau and communities and therefore have the potential to improve New Zealand's economic prospects and the social environment. However, although this may help with recruiting and retaining women scientists, it is often "little more than a public relations exercise" (Devine cited first in Bagilhole et al, 2008:25). Although work-family balance policies and practices have the potential to boost opportunities for women in the workplace, they have minimal impact on organisational culture; can result in a backlash; and work-family remains firmly rooted as women's problem (Ely et al, 2003:5).

By focusing on changing the culture of a workplace the blame is shifted from women (or other minority groups) and placed instead on underlying systemic factors. Interventions from this perspective focus on work practices and processes in order to "revise them in ways that are less gendered and more effective for the organization" (ibid). There is no magic formula here. This course of action is likely to be long-term, extremely challenging, location-specific and requires a high level of commitment. There is also the danger that organizational concerns could be prioritized over gender equity.

In summary Ely et al argue that while attempts to change the culture are made, leadership and mentoring schemes should continue; values given to different qualities and definitions such as success should be examined and reassessed;[41] and we should continue to employ, retain and promote women scientists, though careful attention should be paid to how job descriptions might be revised so as to be more inclusive. Systemic changes help to strengthen such strategies; a change in attitudes may follow.

Conclusion

At present there is a contradiction between being "a good scientist" and "a good mother"; one is not stereotypically women's work while the other is the epitome of femininity. The values, mores and norms associated with the archetypal scientist – rational, objective, competitive, focused, hard-working, obsessive – are different, if not oppositional, to the expectations New Zealand has of mothers – to be sensitive, nurturing, constantly available, and to subordinate their needs to those of their family. Re-assessing values is integral to transforming science culture. Removing the spotlight from women and highlighting the need for men to take an equal share in parenting children is essential at a societal level. The 'problem' needs to be deconstructed and reconstituted, not continually depicted as women's alone.

The tendency to separate public and private lives via the expectation that family life will not intrude into work is as unrealistic. Scientists commonly live in families and such membership comes with responsibilities, fulfillment and sometimes stress. Many narrators find individual

solutions to manage work and family conflict by enlisting the support of partners and family members and arranging suitable childcare, but their best laid plans are frequently frustrated. Worrying about childcare remains a constant concern.

A number of narrators emphasized how family-friendly workplaces advantage men as well as women. Changing science culture should advantage everyone. If time spent at work is equated with commitment, those with family responsibilities are disadvantaged. Working regular seven day weeks cannot be healthy for anyone; nor is trying to be something one is not:

> Identifying as a woman and not fitting within a dominant masculine culture (however that is configured) may place pressure on each individual to alter her psychic state to reduce any subsequent dissonance and anxiety arising from a misfit (Casey cited first in Pringle, 2004:91).

Stress resulting from feeling uncomfortable or an outsider probably underlies why many women leave science. Furthermore, not all women want to assimilate to the male model to survive. Stories emerged of women known to narrators who exited from science because of difficulties such as those discussed above. One narrator discussed the "continual challenge between quality of life and success in science". Further research into why many women (and men) have left science would be a useful addition to the current research. If the leaky pipeline can be stemmed this would have more than just economic benefits. A number of narrators discussed the need for diversity in the scientific community and one argued not only for more women but also for men with a "different mindset". Diversity has the potential to bring different and innovative perspectives to the scientific endeavour.

Strategies such as leadership schemes are useful but they benefit individual women only and, even if they do have the potential to change the culture (and the jury is still out on this), progress is likely to be slow. Policies and processes such as mentoring and work-family balance may also be useful interim measures. However, rather than expecting women (and other minority groups) to adapt to a pre-existing culture that was originally established for men, a more helpful strategy is to examine how science may be re-structured to accommodate diversity and those with family responsibilities. Cultural changes are vital for creating workplaces in which no individual is systematically disadvantaged. The commitment this requires from employers and senior management may not be easily achieved, especially in the present economic climate. Nevertheless, to paraphrase Cecilia Payne Gaposchkin, although in another context, the 'problem' of the title is neither an individual one nor women's alone: "it belongs to the world", in this instance the world of science (Horn, 2009:49).

Oral History Interviews

Campbell, E. interviewed by P. Martin, OHInt 0624-1, Oral History Centre, Alexander Turnbull Library, Wellington

Dingley, J. interviewed by P. Martin, OHInt 0624-3, Oral History Centre, Alexander Turnbull Library, Wellington

Fleming, P. interviewed by P. Martin, OHInt 0624-4, Oral History Centre, Alexander Turnbull Library, Wellington

Mattingley, J. interviewed by P. Martin, OHInt 0624-5, Oral History Centre, Alexander Turnbull Library, Wellington

Other oral history interviews currently in author's possession.

Notes

1 For the rest of this paper when I refer to women in science I am including, unless specified otherwise, women in technology, engineering, medicine and mathematics.

2 More recently in the UK Liz Whitelegg's research with 7-15year olds found that 89%, mostly boys, drew a picture of a male 'mad scientist'. The other 11%, mostly girls, drew pictures that showed scientists as more 'normal' people.

3 A number of narrators had experiences that reinforce this view.
4 On a recent panel I chaired about women and/in science one Eastern European scientist, now working at Victoria University of Wellington, pointed out that the view that women cannot do science was not one with which she was familiar.
5 A scientist is also assumed to be middle-class, white and heterosexual (See Bagilhole et al). Factors such as race, class and sexual identity mean that women in science have diverse experiences. Some narrators have had male mentors who 'nurtured' them and their careers but this is not a universal experience.
6 Lise Meitner is a woman scientist who did not receive the credit for her work that she deserved i.e the Nobel Prize in 1945. Meitner has been described as the most distinguished woman scientist of the time.
7 Cambridge educated Cecilia Payne-Gaposchkin, discoverer of hydrogen as the most abundant element in the universe, produced in the 1920s 'the most brilliant PhD ever written' (Otto Struve). She was the first women full professor at Harvard (1956).
8 For example women outnumber men in primatology and medicine. However, women remain a small percentage of physics and engineering students.
9 For example, opportunities did open up for women scientists during World Wars One and Two but, according to Joan Dingley, by the 1960s goodwill for women 'was not there' (OHInt0624-3).
10 For example, Professor Athene Donald, the deputy head of physics at Cambridge University is quoted as saying 'If you are on high-level committees, you'll be asked to make the tea,' and 'Recently, on a committee, the chairman thought I was the secretary. And I've been in committees where we've been addressed as 'gentlemen', despite the fact that there are women there. It is very off-putting.' However, Nancy Rothwell MRC research professor at the University of Manchester said 'I'm often asked how I manage in a male dominated profession. I just don't recognise this description. I have experienced nothing but support from all my male colleagues.' (Rachel Shields, *Independent* and *The Independent on Sunday*, Sunday, 21 March 2010). Narrators had similarly diverse experiences.
11 'Coming as it did from the gatekeeper of one of the world's great institutions of higher learning, the insinuation of biologically based differences in cognition, coupled with an accusation that advocates of greater equity for females in science were grasping at weak socialization explanations, was radioactive…'.
12 Workshops included in the 2008 Association of Women in the Sciences conference support this view. For example, there was one on managing stress and another on juggling work and preschool children's needs.
13 Many narrators did not approve of affirmative action policies saying they wanted to be judged on merit not given preferential treatment because of their gender.
14 This is no claim to essentialism - all men and all women are not the same and not everyone fits into this bifurcation. The men referred to here were assumed to be white, middle class and heterosexual.
15 Mary Somerville was born in 1780 in Scotland. An astronomer, she has been described as the most remarkable woman of her generation (*Dictionary of National Biography*, 1897).
16 Margaret Cavendish, the Duchess of Newcastle, born in 1623, was a scientific pioneer. Historian Londa Schiebinger has described how Cavendish created an English version of the salon, where French women were building their place in science. The salons were really formal domestic study groups. Influential women ran them, and they drew in the cream of male thinkers. Those women usually acted as referees and questioners - as arbiters of thought.
17 One of her contemporaries claimed that 'whatever originality, greatness and genius' women possess, it is considered a 'reflection of the spirit of the famous man they have loved'.
18 Like many other married women scientists of her time the anti-nepotism rule prevented her from being employed at the same university as her husband. However, once she was offered a position elsewhere, John Hopkins employed her with pay, evidence that rules could be broken.
19 Furthermore, 'doing masculinity' and 'doing work' are often conflated. See Ely et al (2003:7) and Candace West and Don H. Zimmerman in Ely et al.
20 This is not to suggest that one's personal relationships *should* be secondary to one's career, simply that biographically speaking men have traditionally been treated differently from women.
21 The marriage may already have been in trouble when Tinsley found herself pregnant. For a detailed discussion of the issues see Christine Cole Catley, 2006.
22 See Bosch (2007) for a discussion of scientific biographies as cultural texts that 'frequently revolve around forms of masculinity'.
23 For an interesting discussion on merit and science see Gerrard, 2007.
24 Although the metaphor of the 'leaky pipeline' is problematic, it does draw attention to the ways in which women are not simply coming through the science system slowly, but rather are dropping out at each level of the career in greater numbers than men (see Research Directorate-General EC 2001). See also Garforth and

Kerr (2009).

25 See Monosson (2008) for definitions of science and scientist.

26 Monosson's research revealed that many women scientists wished to keep their responses anonymous (2008). Many expressed discomfort with discussing family and work practices on a forum (listserve) for science professionals.

27 Wyer et al (2009) claim that media representation of science and scientists as necessarily male is decreasing.

28 Biologist Richard Lewontin for example claims that science is 'a form of competitive and aggressive activity, a contest of man against man that provides knowledge as a side product' (cited first in Schiebinger, 1999:90).

29 Interestingly, this strategy has its own problems. An overview of more than 100 studies involving evaluations of leaders indicates that women are rated lower when they adopt 'masculine,' authoritative styles, particularly when the evaluators are men or the role is one typically occupied by men'. See Rhode (2003:.162).

30 It was Rosalind Franklin's experimental data that James Watson and Francis Crick used to make their discovery of the double helix of DNA in 1953. They neither sought permission for her data nor acknowledged her contribution to their success when they received the Nobel prize for 'their' discovery. Evidence suggests that Franklin would have made this discovery on her own within three months.

31 Sir Charles Alexander Fleming, KBE, FRS, FRSNZ, FRAOU (1916-1987) was a celebrated New Zealand ornithologist, avian palaeontologist and environmentalist.

32 See for example Dean (2006) for a discussion of the different standards of dress allowable for men and women. Casual dress is more acceptable for men.

33 Generally speaking men who have children are not treated similarly as the expectation is that they will have a wife who will be the primary childcarer.

34 In reality, women take more time off during their earlier careers to meet caregiving responsibilities. But, over a lifelong career, a man is likely to take significantly more sick leave than a woman (See Committee on Maximizing the Potential of Women in Academic Science and Engineering, 2006).

35 Many distinguished astronomers argue that Burnell should have been awarded the Nobel prize for Physics in 1974 for her discovery of pulsars. Instead it was awarded to Sir Martin Ryle and Anthony Hewish (her supervisor).

36 This is reinforced by Schiebinger's findings that more male than female scientists are married, and more women than men are childless.

37 Interestingly, the Ministry of Research Science and Technology shows that female participation in CRIs is higher than usual at board level.

38 However, the evidence demonstrates that anyone lacking the work and family support traditionally provided by 'a wife' is at a serious disadvantage in academe. The majority of faculty no longer have such support. In the US about 90% of the spouses of women in science and engineering faculty are employed full-time; close to half the spouses of male faculty also work full-time.

39 PBRF is the Performance-Based Research Fund.

40 One narrator at the early stages of her career claims that two scientist relationships are now less common as in the current tertiary environment it is too difficult to get jobs for two people.

41 What is meant by success should be unpacked and 'uncritical acceptance of what career success in science is' should be challenged (Evetts cited first in Bagilhole, 2008:.17). 'Success' for women is a double-edged sword: 'When they are not clearly successful, they are presumed to be incompetent. When they are successful, they are not liked.' (Heilmann cited first in Dean, 2006).

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