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THE EXCEPTION AND THE RULE: WOMEN AND THE ROYAL SOCIETY 1945–2010

by

GEORGINA FERRY*

47 Plantation Road, Oxford OX2 6JE, UK

The Royal Society is celebrating 350 years of its Fellowship in 2010. It has admitted women as Fellows only during the past 65 years of its history, and women remain significantly under-represented. In reviewing the Society's activities during the twentieth century, the admission of women for the first time was a key development. Understanding the characteristics of those women who have achieved election may help in the design of policies to increase their number further in future.

Keywords: women; Fellows; elections

FROM EXCLUSION TO ACCEPTANCE

The details of the Society's record in actively excluding women before 1945 were admirably covered by Joan Mason in her paper marking the Golden Jubilee of the first women elected.[1] In the first flush of its enthusiasm the Society allowed Margaret Cavendish, the aristocratic sister of one of the founding Fellows, to attend a meeting and witness experiments in 1667. This particular social experiment was not repeated until 1876, when the Society introduced annual soirées that ladies might attend and (in the case of the physicist Hertha Ayrton in 1899) even demonstrate their own work. In 1832 the Fellows unanimously agreed to commission a bust of the mathematician Mary Somerville from the society portraitist Sir Francis Chantrey, which was placed in its great hall—but there was never any question of admitting her in person, although she was recognized by the Royal Astronomical Society (as an honorary member) and the American Philosophical Society. In 1902 Ayrton became the first (and only) woman to have her candidature for a Fellowship turned down on the grounds of her sex. She was able, however, to read a paper before the Society in 1904, and received the Hughes Medal in 1906. Marie Curie had shared the Davy Medal with her husband Pierre in 1903.

From 1925 the Society acknowledged that under the 1919 Sex (Disqualification) Removal Act, it had no further right in law to deny Fellowships to women. Yet none was proposed until 1943, when influential figures nominated the biochemist Marjory Stevenson and the crystallographer Kathleen Lonsdale. The then President, Lonsdale's boss at the Royal

*mgf@georginaferry.com

Institution, Sir Henry Dale, organized a postal vote to win approval for an amendment to the statutes, explicitly permitting women candidates, and both women were duly elected in 1945.

Other learned societies were more enlightened, with the Royal Astronomical Society admitting women as honorary members in the nineteenth century and as Fellows in 1915, and the Zoological and Royal Entomological Societies, founded in the first half of the nineteenth century, never excluding women. The Geographical Society, after a brief tussle at the end of the nineteenth century, had 211 women members by the end of 1914. Abroad, a handful of women of the Enlightenment, such as Princess Dashkova of Russia, were elected to the Royal Academy in Sweden, the Imperial Academy in Russia, and the American Philosophical Society, although some of their successors had to wait until well into the twentieth century. The National Academy of Sciences in Washington DC elected its first woman in 1925, but it took the Académie des Sciences in Paris until 1979 to elect its first female full member, the mathematical physicist Yvonne Choquet-Bruhat.

By 1995, the 50th anniversary of the election of the first women to the Royal Society, 52 women had been elected under normal statutes, 2 under Statute 12 (for service to the cause of science) and 5 as Foreign Members. Mason conducted an analysis of this cohort by marital and maternity status, by subject and by main place of work. I have extended her analysis to include those elected up to 2009, providing the opportunity to compare the pioneers with those elected since social changes and equal-opportunities legislation expanded the horizons of young women embarking on careers.

The female Fellowship to 2010

The total number of women who have been elected (excluding Foreign Members and those elected under Statute 12) is now 104; in other words, the total has exactly doubled in the 15 years since 1994. This represents a considerable escalation in the rate of elections (figure 1). It seems clear that by the mid 1990s the Society had moved from electing a few outstanding women to making a conscious effort to seek out prospective female candidates. Since 2001, for example, the minimum number of Fellows needed to sign a nomination has been reduced from six to two, explicitly to ensure that women and those in emerging research areas are not disadvantaged. The year 2003 was a bumper year, with nine women elected, and there have been at least two in every year since 1998. The Society's Web site notes that 'over the past 8 years 10 per cent of new Fellows . . . have been women', although their representation among living members still hovers at only a little over 5%.[2] It is too soon to tell whether the number of those elected each year will continue to rise, or whether it has simply reached a slightly higher plateau. For comparison, since 2001 women have consistently represented between 12% and 25% of new members elected to the US National Academy of Sciences each year.

The total number of female Foreign Members has more than doubled since 1995, from 5 to 13; the 9 who are still living make up 6.5% of current Foreign Members. Although two female Fellows and four Foreign Members have been Nobel laureates, a Nobel Prize (or the likelihood of one) has not been enough to guarantee election. Seven women who won Nobel Prizes after 1945 were not admitted to Foreign Membership either before or afterwards; two of those became laureates only in 2009, but all were honoured for work performed long before.

Mason noted that one-third of the female Fellows she listed came from London, and one-quarter from Cambridge. Among the total of 104 women Fellows elected so far, the

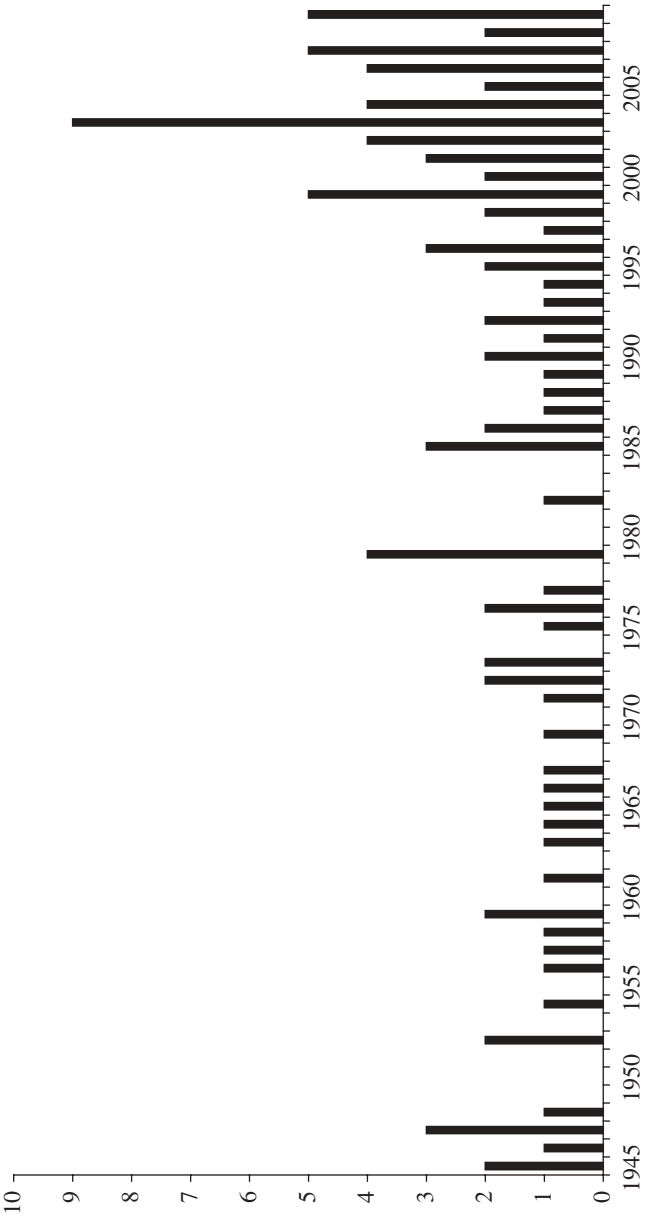

Figure 1. Elections of women Fellows by date.

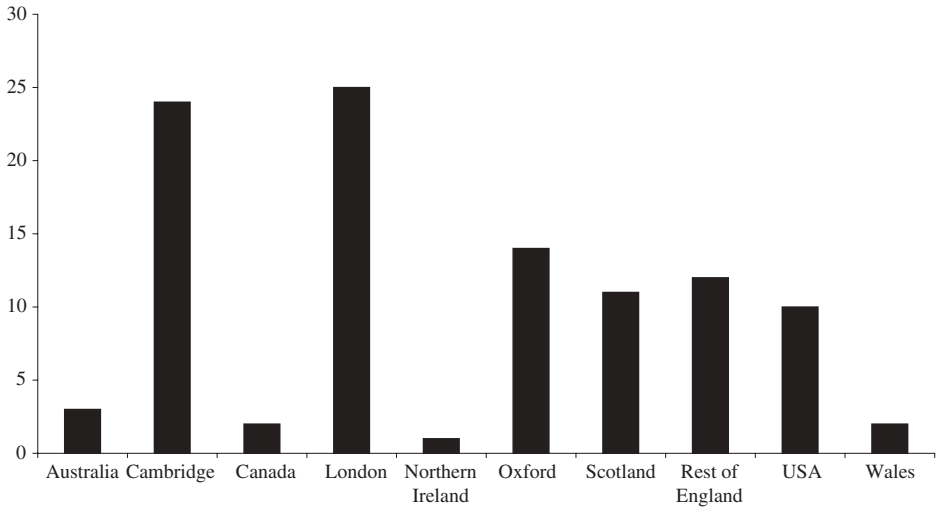

Figure 2. Main place of work of women Fellows ($n = 104$).

proportion from London drops to 24%, but, at 23%, Cambridge maintains a consistently high proportion. Oxford musters 13.5% of the total, whereas the whole of the rest of England accounts for only 10.5%, barely more than Scotland at 9.6%—almost entirely accounted for by Edinburgh (figure 2).

Mason found that 83% were biological scientists (mostly biochemists), and commented, 'No woman has been elected from the "traditional" fields of mainstream chemistry or physics.' That figure has barely changed, with 78% of the total now coming from the life sciences, and only 22% from the physical sciences (figure 3). Whether in physical or life sciences, there remains a very strong tendency for these high-achieving women to work in fast-growing, interdisciplinary fields such as molecular biology or polymer chemistry.

Mason went on to look at the marital and childbearing status of her sample, and found that the very high level of childlessness (20 out of 26) among the first women elected became less pronounced with time. I chose to divide the women into two groups by date of birth rather than date of election. There were equal numbers of married and unmarried Fellows among those born in 1940 or earlier, whereas among those born later there were more than twice as many married as unmarried (figure 4). The percentage who were childless fell from 63% among those who were born in 1940 or earlier to 40% among those born between 1941 and 1965 (figure 5). Although it is encouraging that women are now less likely to make a straight choice between a scientific career and family life, the later figure for childlessness is still extremely high. Even an increasing trend towards childlessness among women in England and Wales, from a low of 10% among those born in 1945, reached only 19% of those born in 1960.[3] A recent longitudinal study found that childless women were disproportionately likely to work in technical, managerial or professional roles.[4]

Of those who do have children, family sizes among women Fellows (divided into two groups by date of birth as above) have fallen from an average of 2.7 to 1.8 children. I have not conducted a comparison with male Fellows, but studies cited in Mason's paper consistently show that women scientists have a lower marriage rate and fewer children than their male colleagues.

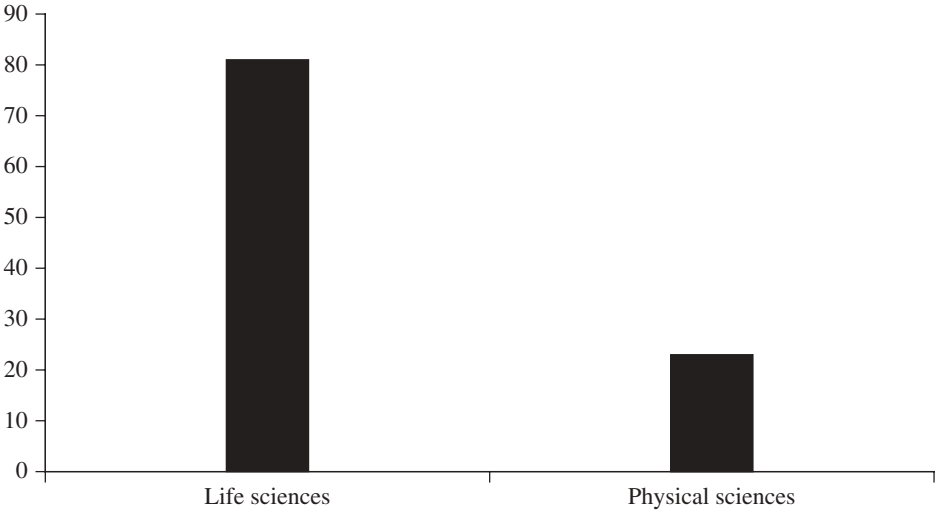

Figure 3. Numbers of women Fellows by discipline ($n = 104$).

How do we account for exceptional women?

The bald statistics make it clear that women who are elected to Fellowships are by definition exceptional. One can ask—as many have been doing for at least the past 40 years—why there are not more. Answers range from the unwillingness of girls to study science subjects (emphatically no longer true in the biomedical field, and becoming less true in physics, chemistry and mathematics) to the extreme difficulty of combining family life with the workload involved in top-level research. A recent Stanford University study confirmed that female scientists in the USA spend twice as much time on household tasks as their male counterparts.[5]

Rather than exploring these questions yet again, I wish to ask what factors have enabled women Fellows to receive the accolade of their peers. These questions might at some future date provide the basis of a more detailed research study, based on qualitative assessments of each Fellow's personal characteristics and social, educational and scientific environments relative to both male and female scientists at various levels of achievement.

Are scientists born or made?

In the Royal Society's recent research project on the importance of role models for people following careers in science, the most common answer given to the question 'Why did you go into science?' was 'I was just good at it.'[6] For those women who reach the top, it goes without saying that their success is based on some combination of relevant cognitive and personal skills and, for practical subjects, experimental dexterity.

How far gender influences such skills has been a topic of heated debate. Recent data show that on average the performance of boys and girls in both science and mathematics differs little. There is some evidence that boys outnumber girls above the 95th centile in

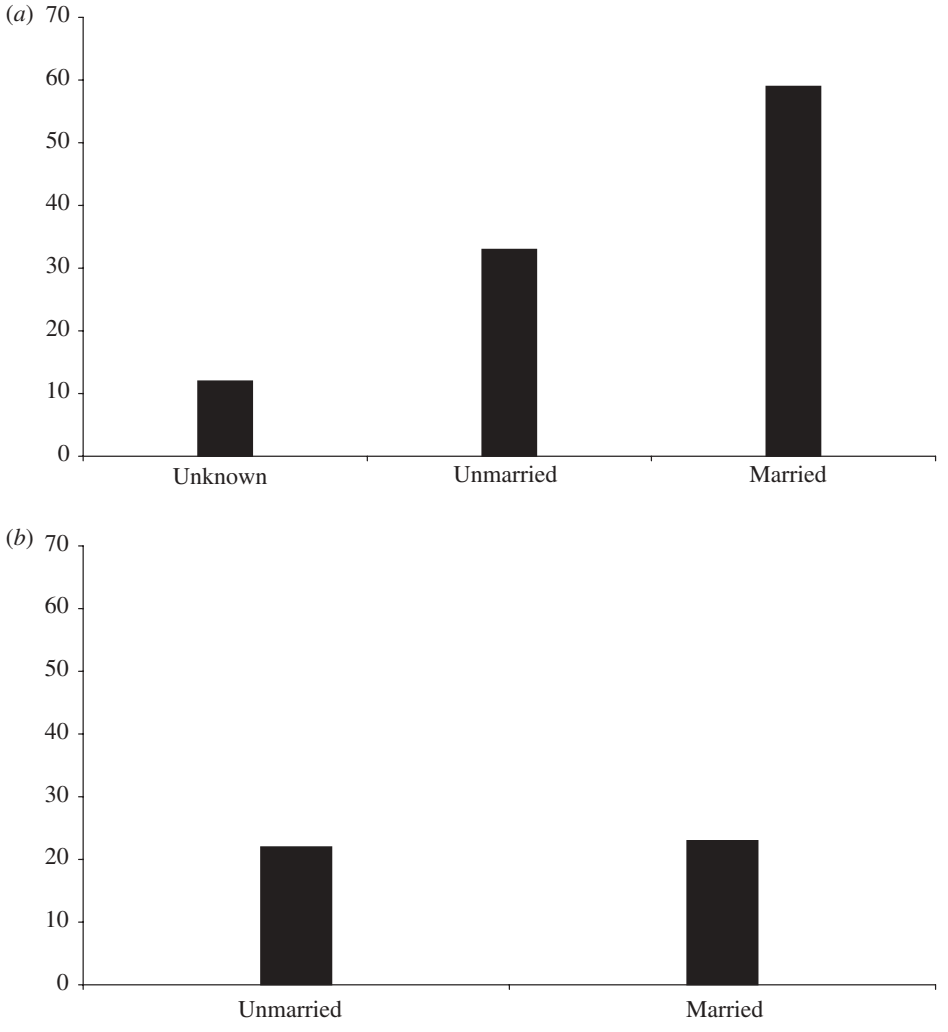

Figure 4. Marital status of women Fellows. (*a*) All Fellows ($n = 104$). (*b*) Fellows born before 1936 ($n = 45$).

mathematical ability. However, on the basis of a study of recent mathematics scores that included all secondary school children in 10 states in the USA, Janet Hyde and her colleagues concluded, 'Gender differences in math performance, even among high scorers, are insufficient to explain lopsided gender patterns in participation in some STEM [science, technology, engineering and mathematics] fields.'[7]

Women have almost reached parity among mathematics undergraduates in the USA, although they represent much smaller proportions in physics and engineering. In the biomedical sciences in the UK, young women have reached parity with their male colleagues at PhD level, and outnumber them as junior doctors. The numbers in physical sciences and technical subjects have also increased, although women remain in a minority. It seems safe to draw the obvious conclusion that early aptitude and inclination are prerequisites for a scientific career, but it is by no means obvious that gender

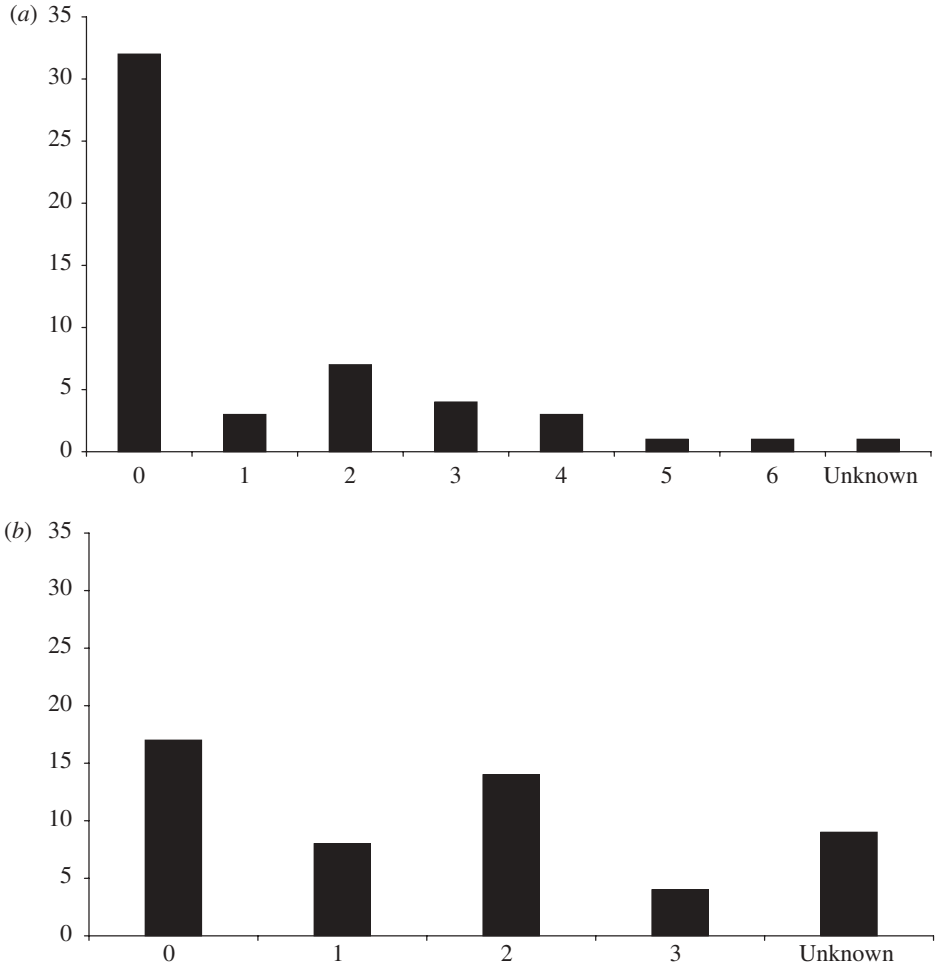

Figure 5. Number of children among women Fellows. (*a*) Born in 1940 or earlier ($n = 52$). (*b*) Born between 1941 and 1965 ($n = 52$).

differences in aptitude and inclination account for the gross gender disparity that persists at senior levels.

Does early upbringing have an effect?

Aptitude needs to be given an opportunity to flourish. The early women Fellows were young women at a time when higher education for girls was seen in some social circles as a deterrent to a 'good marriage', while in others it was an unwarranted delay before the girl in question might start working and contributing to the family income. Those who succeeded generally had parents, of whatever social class, who took their daughters' intellectual aspirations seriously. Parents' (particularly mothers') occupations, their

attitudes to the education and social role of girls and women, position in the family, and number and sex of siblings are all factors that might have had a decisive influence on a girl's determination to follow a scientific career and reach the top. The attitudes of teachers and peers and the presence or absence of suitable role models also need to be taken into account: what percentage of women FFRS attended single-sex schools, for example? There are insufficient reliable data on these social factors to draw strong conclusions; it is an area that would warrant further study.

Climbing the ladder

The Society attributes its persistent gender imbalance to the 'small percentage of female professors in science subjects at UK universities', implying that a chair is a necessary prerequisite for election. This certainly was not always the case: Dorothy Hodgkin had only just been appointed a departmental demonstrator (junior lecturer) at Oxford when she was elected in 1947, and Miriam Rothschild (elected in 1985 at the age of 77 years) never held an academic position. But a commanding position in the academic hierarchy undoubtedly contributes to the support base necessary for nomination and eventual election. The choice of PhD supervisor may be critical in building such a base.[8]

The Royal Society has made an effort to recognize the difficulties that face young women who need to establish their independence as researchers at the same period in their lives that they are likely to be having children. The four-year Dorothy Hodgkin Fellowships were established by the Society in 1995 to fund early career researchers who needed some flexibility in their working lives, either through deferring the award for a period or working part time. Although the awards are open to both sexes, the vast majority have been awarded to women. The same flexibility has now been extended to other Royal Society awards such as University Research Fellowships. So far there have been 167 Dorothy Hodgkin Fellows (DHFs), of whom 57 remain in post.

In all, 46% of past DHFs and 61% of current DHFs who responded to a recent survey had taken a career break during their Fellowship, most of them for maternity leave.[9] Of past DHFs, more than two out of three were now in tenured positions. Only 5% had reached the rank of professor, but this probably reflects the fact that even the earliest DHFs will still be in the middle of their careers. The scheme is highly competitive, with a success rate for applicants of between 6% and 10% each year, and is clearly seen as a valuable first step towards an independent research career.

What to do, and where?

The early entry of the crystallographers Kathleen Lonsdale (1945) and Dorothy Hodgkin (1947) strongly supports the view that working in a new, interdisciplinary area is a great advantage for women, enabling them to progress farther and faster than contemporaries in more traditional fields. Both were pioneers, Lonsdale with her work on the benzene ring in the 1920s and Hodgkin as one of the first ever (with her PhD supervisor J. D. Bernal) to produce a diffraction pattern from a protein crystal; she was later the first to solve the structure of a natural product of uncertain formula (penicillin) using only crystallographic methods.[10] The same is true of more recent Fellows: Julia Higgins FRS, chair of the

Society's Equality and Diversity Network, was among the first to apply neutron scattering to the study of polymers and, as she wryly put it in an interview, 'As a woman, if you are halfway competent you have a huge advantage in that they all remember you.'[11]

The choice of institution also seems to have a larger bearing on female success than it does for males. Mason comments, 'a significantly larger proportion of the female compared with the male Fellowship is from London or Cambridge.' She attributes her findings to the ease with which both halves of a couple might find senior posts in these centres of scientific population. I wonder whether it might not be at least as important for a woman to work somewhere where her visibility to influential male colleagues is high. Certainly one might conclude that if your daughter has ambitions to become an FRS, she would be wise to set her sights on Cambridge as a first step.

The family way

With many notable exceptions—Kathleen Lonsdale and Dorothy Hodgkin each had three children—women FFRS have been more likely than men, and much more likely than women in the general population, to remain childless. In an effort to dispel the notion that top-flight research and motherhood don't mix, Ottoline Leyser FRS used a Royal Society Rosalind Franklin Award to produce a booklet illustrating the careers of 64 women, all independent research group leaders and including several FFRS, who were also mothers.[12] A small number, such as Carol Robinson FRS, returned to research after taking a career break (in her case it was for eight years) while their children were small. Family life can be combined with a research career, but no one pretends that it is easy. Those that succeed are typically committed to continuing their research at all costs, ferociously well organized, have partners who do their share, and have access to paid help in the home or other forms of daycare.

Conclusion

Female Fellows do not fit a single model, but it is possible to develop a hypothesis about the kind of woman who is likely to reach such a level of distinction. She is passionately interested in her subject and had a natural aptitude for it from an early age. She was encouraged in her interest by one or both parents. She either received an excellent school education or was sufficiently motivated and supported to make up for her school's deficiencies through independent study. She attended Cambridge or London University, where she showed evidence of independent thought and was successful in obtaining a place to continue research for a PhD. She chose a growing, interdisciplinary field, a rising or established star as a supervisor and a laboratory where the availability of new techniques meant that discoveries would come fast, and she built up an impressive publication record. Her choice to have one or two children was made only after careful consideration and planned to fit in with her career; she somehow found the funds to pay for childcare, and relies on her partner to be supportive. Against all the demands of teaching, administration and family life she has made research her number one priority: she works long days and manages her time minutely. She is an excellent networker. She

is determined to succeed on the same terms as men, although once she has achieved her aims she may well lend her support to schemes such as the Dorothy Hodgkin Fellowships.

Further policy initiatives may well help to expand the pool of women who fit this model. To target such initiatives effectively, further research is needed to establish how far some of the factors suggested here have been critical in enabling women scientists to reach the top.

Notes

1 Joan Mason, 'The women Fellows' Jubilee', *Notes Rec. R. Soc.* **49**, 125–140 (1995).
2 See http://royalsociety.org/Gender-profile
3 Office for National Statistics, *Birth Statistics, 2008*. See www.statistics.gov.uk/pdfdir/births1209.pdf
4 Martina Portanti and Simon Whitworth, 'A comparison of the characteristics of childless women and mothers in the ONS Longitudinal Study', *Popul. Trends* (no. 136), 10–20 (2009).
5 Londa Schiebinger and Shannon K. Gilmartin, 'Housework is an academic issue', *Academe* **96** (1), 39–44 (2010).
6 See http://royalsociety.org/Role-Models-guide
7 Janet S. Hyde, Sara M. Lindberg, Marcia C. Linn, Amy B. Ellis and Caroline C. Williams 'Gender similarities characterize math performance', *Science* **321**, 494–495 (2008).
8 See also Peter Morris, 'Does membership of the Royal Society affect careers? A trio in twentieth-century organic chemistry', *Notes Rec. R. Soc.* **64** (2010) (this issue).
9 Executive Summary, Dorothy Hodgkin Fellowship Scheme Evaluation (Royal Society Evaluation Panel, November 2008).
10 Georgina Ferry, *Dorothy Hodgkin: a life* (Granta, London, 1998).
11 Michael Kenward, 'Profile: Dame Julia Higgins DBE FREng FRS', *Ingenia* online (September 2007). See www.ingenia.org.uk/ingenia/articles.aspx?Index=423.
12 Ottoline Leyser (ed.), *Mothers in science* (The Royal Society, London, 2007).