4 Making twentieth-century scientific heroes

From: Maureen McNeil, Feminist Cultural Studies of Science and Technology, London: Routledge, 2007.

> By virtue of their ascribed feminine characteristics, women hardly fit the category of 'scientist' at all.
>
> (Van Dijck 1998: 24)

> Science seldom proceeds in the straightforward logical manner imagined by outsiders. Instead, its steps forward (and sometimes backward) are often very human events in which personalities and cultural traditions play major roles.
>
> (Watson 1969: ix)

Chapter 3 considered different versions of Newton as a British national scientific hero which emerged over several centuries. This chapter, in contrast, explores the making of scientific heroes in the last third of the twentieth century. As noted in Chapter 3, Newton's achievements have been marked and celebrated in a diffuse range of British cultural sites. Thus, in terms of cultural forms the scope of my analysis was broad, ranging across a variety of sites of Newton's figuration: from eighteenth-century poetry to twentieth-century postage stamps. This chapter is focused on a very specific cultural form – popular science biographies that appeared in the English-speaking world between 1968 and 1983. It explores the making of new scientific heroes of the late twentieth century in and through this distinctive cultural form.

The chapter begins with brief introductions to the four books that are my central concern. I start with the most popular scientific memoir of the twentieth century, James Watson's *The Double Helix* ([1968] 1969), and I then introduce three widely circulated biographies of women scientists of the twentieth century: Ann Sayre's *Rosalind Franklin & DNA* (1975), June Goodfield's *An Imagined World: a story of scientific discovery* ([1981] 1982) and Evelyn Fox Keller's *A Feeling for the Organism: the life and work of Barbara McClintock* (1983).

The books

The four books that are my central concern are as follows:

- James Watson, *The Double Helix* ([1968] 1969): this text constituted Watson's personal account of the research associated with the discovery of the double-helix structure of DNA. The book recounts the collaboration between Watson (a young American researcher who had recently earned his PhD) and Francis Crick (an older, English PhD student), working in the Cavendish Laboratory at Cambridge University between 1951 and 1953, which led to the construction of a model of DNA and the publication of a key paper on this topic in *Nature* (April 1953). This research resulted in the award of a Nobel Prize to Watson and Crick, together with Maurice Wilkins (King's College London) in 1962.
- Ann Sayre, *Rosalind Franklin & DNA* (1975): this biography of physical chemist and crystallographer Rosalind Franklin (1921–58) was written by the scientist's friend, who was also the wife of one of her colleagues. The book attempts to put the record straight about Franklin's role in the discovery of the double-helix structure of DNA. It contests the account of this discovery provided by James Watson in *The Double Helix* and the negative portrayal of Franklin offered in that text. As just noted, Watson, Crick and Franklin, along with their former colleague at King's College, London, Maurice Wilkins, were awarded a Nobel Prize in 1962 for their work on the structure of DNA. Rosalind Franklin died of cancer in 1958 at the age of 37.
- June Goodfield, *An Imagined World: a story of scientific discovery* ([1981] 1982): Goodfield, an established historian of science and scientific journalist, documents the work of Dr Anna Brito (the pseudonym used in the book) (b.1942), a Portuguese immunologist whose research carries her to posts in London, Glasgow and New York. The account is based on Goodfield's observation and extensive communications (interviews, letters, phone calls, tape recordings) between the author and Anna from 1975 to 1980. It focuses particularly on Anna and her international research team based in their laboratory in New York as they investigate the role of iron in the functioning of the immunological system, especially in dealing with cancer.
- Evelyn Fox Keller, *A Feeling for the Organism: the life and work of Barbara McClintock* (1983): Keller, a former physicist, turned historian of science and feminist theorist, wrote this biography of the US geneticist Barbara McClintock (1902–92). McClintock was awarded the Nobel Prize for Medicine and Physiology shortly after this book appeared (1983) for her work on gene transposition, which showed that genes 'jump', that their behaviour is random and that they can move between cells.

While Watson produced the most popular scientific memoir of the twentieth century, these other books were the most widely circulated accounts of women's lives as working scientists available in the English-speaking world in the 1970s and 1980s. Watson's narrative haunts the other texts. This is most obvious in the case of Sayre's book, which is a direct rebuttal of *The Double Helix*, but is apparent in the other books as well. There are striking connecting threads and intertextual references linking these three biographies of female scientists. June Goodfield's Anna reads and responds to Sayre's book on Franklin: her response to this text informs her perspectives on difficulties women experience in pursuing scientific careers. Both Goodfield and Keller use the notion of 'winners' and

ISBN 978-0-415-44537-5

'losers' in science (pertaining to scientific discovery), which was the leitmotif of James Watson's *The Double Helix* and was adapted more critically to frame Sayre's story of Franklin.[1] Keller (1981), who reviewed Goodfield's book, quotes it directly in the conclusion of McClintock's biography, linking the Nobel Prize winner's methodological approach – her 'feeling for the organism' – with Anna's orientation towards research summarized in the younger scientist's observation that '[i]f you want to really understand about a tumor, you've got to *be* a tumor' (Keller 1983: 207; Goodfield 1982: 226).

The Double Helix: rewriting scientific heroism

As I have outlined, *The Double Helix*, which was first published in 1968, was James Watson's personal memoir of the research associated with the discovery of the double-helix structure of DNA. The pre-publication controversy surrounding this book indicated that there was a lot at stake in putting this personal account into the public domain. Watson had circulated drafts of the text to a number of colleagues, and his two co-holders of the Nobel Prize for the discovery of the double-helix structure of DNA – Francis Crick and Maurice Wilkins – objected to its publication. In an unprecedented decision, the Board of Harvard University Press decided to halt publication (Stent 1980a; Yoxen 1985). Watson published with Atheneum Press instead and the book became a bestseller, offering an influential account of leading-edge scientific research. The pre-publication furore around this text was, in many ways, indicative since *The Double Helix* conjured a powerful image of modern scientific heroism, which was both highly controversial and very attractive.

Watson played with form and was influenced by various literary precedents. He apparently modelled the text on Sinclair Lewis' *Arrowsmith* ([1924] 1953) and the original title chosen for his book was *Honest Jim*, associating it with the popular Kingsley Amis novel *Lucky Jim* (1954). The published version of *The Double Helix* folded the trope of scientific discovery into the popular genres of the detective story and the memoir of youthful adventure. This meant that readers could engage with the text in a variety of ways. Watson provided technical detail about the research and represented his version of the scientific puzzle that could appeal to scientists (Stent 1980b). But a wider readership was offered a range of other ways into Watson's story. Following the generic route for readers of detective fiction, they could be carried through the twists and turns of the narrative, with Watson as sleuth, picking up the clues pertaining to the structure of DNA.

Ambition, controversy and concomitant broad popular appeal propelled this book and helped to make it an important and distinctive text in the history of science. Watson had indicated his concern to throw off the 'rather mystical' (Sayre 1975: 156–7) image of scientific discovery and to present a realistic picture of the doing of science. These sentiments cannot be taken at face value, nor can the trope of realism be invoked to explain or naturalize Watson's story of scientific adventure. Instead, my proposal is to delineate the features of James

Watson's heroism to gauge the significance of this portrait of the contemporary scientist and science. (I am referring here to the character represented in the text and not to the author/scientist himself.) Watson, in effect, projected an image of the quintessential modern, secular scientific hero and he thereby sketched a set of attributes which became associated with this late twentieth-century figure. The modern scientist was, according to Watson's vision, ordinary, sexy and racing, and the instantiation of these tropes constituted a new model of scientific heroism. It is my contention that *The Double Helix* is a crucial text in the history of modern natural sciences because of this powerful refiguring of scientific heroism. While some of these tropes have been highlighted by previous commentaries on this text, there has not been an exploration or evaluation of this dramatic reconfiguration and of the interplay of these elements. The first section (pp. 47–51) of this chapter outlines this refiguration, while the second section (pp. 51–67) considers the consequences of this casting of scientific heroism for the presentation of female heroes of twentieth-century science.

The scientist as ordinary guy

In a commentary about *The Double Helix*, Francis Crick referred to Watson's desire 'to show that scientists were human, a fact only too well known to scientists themselves but apparently not, at the time, to the general public' (Crick 1974: v). While Crick makes light of this facet of the book, it was a key feature of Watson's self-portrait: he presented himself as an 'ordinary guy'. Readers were thereby invited to identify with him and encouraged to see his youthful mishaps and misdemeanours as amusing and even endearing (even if some would find these annoying). It has been suggested that this image counteracted established popular images (from literature and film particularly) of the scientist as mad or bad (Haynes 1994; Van Dijck 1998; Frayling 2005).[2] But such representation also provided readers with points for imaginative identification: the world of science was made more accessible, more open, more likely to garner public interest and support.[3] Of course, as I shall detail on pp. 49–51, these imaginative positionings were also intensely gendered. Indeed, from an historical perspective Watson's tale proclaimed the secularization of contemporary science and its heroes, eschewing their clerical roots and associations (Noble 1992; McNeil 1997). Moreover, this alternative persona (alter ego) softened the image of the driven, competitive (or possibly frightening) scientific hero. The conjured portrait of a youthful Jim Watson, as an ordinary guy, resonated with readers attuned to the adventures of *Lucky Jim* (Kingsley Amis' hero) (Amis 1954), Holden Caulfield (hero of J. D. Salinger's *The Catcher in the Rye* [1951] 1958) and Jack Kerouac's *On the Road* (1957).

Secular, manly heroes

Jim Watson was a thoroughly modern hero and, like his literary counterparts, he flourished in a 'man's world'. Affiliating with Kingsley Amis' *Lucky Jim* and

much of the popular adventure and detective fiction of the 1950s and 1960s, *The Double Helix* displayed and enacted the characteristic gender inequalities and heterosexism of the period. Science had long been established as 'a world without women' (Noble 1992), but Watson's story made modern science (and male scientists) sexy by exposing, celebrating and policing its modern heterosexist character. There were four key elements to Watson's enactment of the heteronormativity of science:

- contemporary heteronormative practices and conventions were portrayed as facilitating and supporting the careers and creativity of male scientists;
- homosocial dynamics (male friendship, collegiality and competitiveness) were displayed as providing the drive for scientific achievement and progress;
- scientific talent was aligned with masculine heterosexual interest and prowess;
- feminism and feminists (actual or fantasized) were represented as threatening the progress of science.

Heteronormative science

Two key female characters in Watson's story were his sister, Elizabeth Watson, and Odile Crick, the wife of his scientific partner, Francis Crick. Early in the narrative, Watson entertains the hope that Elizabeth's attractiveness will be an asset in his pursuit of the secrets of DNA. Having observed that Maurice Wilkins seemed to 'notice that my sister was very pretty', Watson speculated that 'if Maurice really liked my sister, it was inevitable that I would become closely associated with his X-ray work on DNA' (Watson 1969: 28–9). Watson's expectations were not realized, but this anecdote is apocryphal, amplifying somewhat ludicrously the expectation that heterosexual relations would bolster masculine scientific achievement.

Following a similar pattern, Watson represents Odile Crick as furnishing wifely support (despite Crick's extramarital flirtations) through the provision of wonderful meals, domestic comforts and pleasant socializing. Odile is shown as incapable of participating in science in any other way, since, as Watson explains, '[n]ot only did she not know any science, but any attempt to put some in her head would be losing a fight against the years of her convent upbringing' (Watson 1969: 63). Indeed, most of the women who appear in Watson's story are presented as servicing men of science in diverse ways, including through the provision of sexual entertainment and distraction by 'the popsies' (au pairs) and 'the girls' (undergraduates) around Cambridge. Elizabeth Watson is an indicative figure in her brother's tale as the only information provided about her pertains to her boyfriends, her fiancé, her husband and, in the coda, her children. Her main contribution to the plot (and to science) is her typing of the crucial article (which was to be published in *Nature*) in which Crick and Watson presented their research on DNA structure.

Science as a man's world

While heterosexual relations provide the backdrop and the maintenance framework for heroic scientific enterprise in Watson's narrative, he shows male friendship, collegiality and competitiveness as the dynamic factors in the shaping of modern science. *The Double Helix* is, in fact, a classic adventure story that revolves around the creativity of a male partnership. Watson also traces an almost exclusively male research network that sustains and challenges the dynamic duo. Watson does register some aspects of these gender restrictions in pointing out that King's College London, where Rosalind Franklin and Maurice Wilkins worked in the early 1950s, barred women from key locations for collegial exchange, including the senior common room. In this world of men, the spur of rivalry and competition is ever-present. In Watson's story, Linus Pauling, working at the University of California, is portrayed as the main rival in the 'race' to uncover the structure of DNA.[4]

Scientific heroes and heterosexual prowess

Although Watson highlights the homosocial aspects of leading-edge science in the second half of the twentieth century, he assures his readers that modern scientists have thrown off other elements of their vestigial clerical legacy (Noble 1992). Indeed, he provides ample (if not excessive) evidence that he and his colleagues are actively heterosexual. The book includes recurring references to Crick's attraction to young women and Watson's rather envious observations of his scientific partner's skills in flirtation. Watson also recalls ostensibly amusing or embarrassing encounters with other colleagues while they were engaged in heterosexual activities. Overall, *The Double Helix* conveys the image of the modern scientific hero as eschewing clerical celibacy, displaying instead the robust heterosexuality that became a feature of Britain's 'swinging 1960s'.

The feminist anti-hero

Watson's enthusiastic picture of the modern scientific hero as an ordinary guy who exuded conventional heterosexual masculinity was accompanied by a very different representation of Rosalind Franklin, who was the only woman shown actually doing science in the book.[5] Franklin is portrayed as difficult, closed to and in some ways obstructing the road to scientific progress, and, even, at one point, physically threatening. Watson also recounts that she was unfeminine and accordingly unattractive. Although this vituperative portrait of Franklin was subsequently contested and condemned (Sayre 1975; Yoxen 1985; Van Dijck 1998; Maddox 2002), Watson established a powerful trope that had lingering purchase: feminism as threatening to modern science.

Watson introduced Rosalind Franklin in a vividly evaluative passage:

> By choice she did not emphasize her feminine qualities. Through 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, while at the age of thirty-one her dresses showed all the imagination of English blue-stocking adolescents.
>
> (Watson 1969: 20)

This passage shows Rosalind Franklin as subject to visual scrutiny, her appearance and, concomitantly, her femininity assessed by a dishevelled, ambitious junior researcher. Watson's insertion of 'by choice' suggests that Franklin was engaged in a concerted strategy of rejection of the norms of femininity. He brings together evidence of this deliberate flaunting of femininity, with a reference to 'blue-stocking adolescents'. Thus, Watson's introduction of Franklin explicitly links her with feminism. He then offers a crude and, by his own admission, rather spurious explanation of Franklin's feminine deficiencies by attributing her feminism to a pathological mother-daughter relationship:

> So it was quite easy to imagine her the product of an unsatisfied mother who unduly stressed the desirability of professional careers that could save bright girls from marriages to dull men. But this was not the case. Her dedicated, austere life could not be thus explained – she was the daughter of a solidly comfortable, erudite banking family.
>
> (Watson 1969: 20)

The phrase 'it was quite easy to imagine' provides the clue that what is displayed here is Watson's own imaginative landscape. Indeed, Sayre (1975) would later charge that Watson's book circulated a fictional version of Franklin. Sayre's claim is, in her terms, justifiable, but instead I prefer to draw attention to the broader imaginative landscape that sustains and shapes *The Double Helix*, in a way that unsettles the distinction between fact and fiction.

Later in the text, Watson reflects on Franklin's position in Maurice Wilkins' laboratory at King's College London, offering the assessment that 'she had to go or be put in her place' (Watson 1969: 20). Moving beyond this specific response to Franklin, Watson surmises that '[t]he thought could not be avoided that the best home for a feminist was in another person's lab' (Watson 1969: 21). His assessment of Franklin entails a summary of expectations regarding feminists – or, indeed, aspiring women more generally – in many scientific settings during this period. Watson's portrait of modern science suggested that women had to be kept in their place and that feminism threatened scientific progress. Towards the end of the book, Watson expresses relief when Franklin apparently accepts his and Crick's version of the double-helix structure. This prompts a striking reappraisal: 'Her past uncompromising statements on this matter thus reflected first-rate science, not the outpourings of a misguided feminist' (Watson 1969: 134–6). According to this evaluation, in supporting Watson and Crick's theory Franklin proved that she was a good scientist, rather than a feminist.

Racing, racy, competitive scientists

The third trope of Watson's imaginative construal of scientific heroism was speed – his heroic scientific adventure was portrayed as a 'race'. From the perspective of the early twenty-first century such a perception of leading-edge bioscience may seem so commonplace that it is difficult to register the significance of Watson's imaginative framework. However, it is striking that, in many respects, Watson portrayed a rather relaxed world that Edward Yoxen has characterized as a 'Golden Age' of scientific work 'when people had time to play tennis, go to the cinema and try somehow to make contact with members of the opposite sex' (Yoxen 1985: 178). José Van Dijck (1998) has unpacked some of the background to this trope, contending that the Cold War and the space race were influential in Watson's conceptualization of science. Moreover, an emphasis on speed and competition came to seem appropriate as pressures around funding for science became increasingly important in the United States and some other Western countries in the later decades of the twentieth century. As Yoxen notes, '*The Double Helix* was a tract on competition in science and the constant need to confront it' (Yoxen 1985: 178).

The identification of molecular biology with speed and competition became crucial to its emergence as the leading-edge of technoscientific development in the second half of the twentieth century. Yoxen explains:

> Having developed from the marginal pursuit of a few far-flung pioneers braving the disapproval of their peers, molecular biology became the site of some of the most intense competition in science and acquired the reputation as a field in biology where the real excitement lay and where the most daunting problems would continue to be found
>
> (Yoxen 1983: 43)

In fact, speed and competition have become dominant features of late twentieth- and early twenty-first century biosciences. In genetics and genomics (particularly during the lead-up to the 'completion' of the Human Genome Project in 2000) scientific heroes have been consistently represented as competitors in an international race. In this respect, Watson's image of racy, competitive scientific heroism has been thoroughly normalized.

Other lives in science

Watson told his own 'personal' story of scientific discovery and *The Double Helix* was, in many senses, a cocky tale, written in the aftermath of the award of a Nobel Prize. The other books considered in this chapter are biographies rather than autobiographies. Sayre, Goodfield and Keller undertook to tell stories of

other lives in science.[6] While many scholars have contended that these genres merge, signalling this by the use of the meta-category 'auto/biography' and through analytical work oriented around this fusion (Stanley 1992), the distinction in form is not insignificant in relation to these texts. *The Double Helix*'s specifically *auto*biographical form suggests both Watson's personal confidence and the broader cultural consolidation of men's place in Western science in the middle decades of the twentieth century which gave him 'voice', enabling him to tell his own story. In relation to Watson's text, the biographical form of the telling of the lives of these female scientists indicates both their more precarious positions within their scientific communities (discussed on pp. 53–7) and the more general profile of women within the natural sciences at this time, when it was difficult for women to have a life and a voice in this world.[7]

Nevertheless, as with Watson's tale, there were personal dimensions to all of these books. There was an acknowledged personal bond which propelled these projects and the authors became, in effect, public advocates for the scientists whose lives they researched. In Sayre's case, a strong personal friendship and sense of loss (in the wake of her friend's early death) sustained the author, expressed in the reflection '[t]o this day, I miss her' (Sayre 1975: 187). Sayre's admiration for Franklin inspired her to attempt to set the historical record straight on the scientist's achievement. Her identification was so intense that it led to her rhetorical claim that had the scientist lived longer 'she could scarcely have been overlooked' for the Nobel Prize (Sayre 1975: 188). For Goodfield, friendship and admiration emerged from, rather than being the sustaining background to, her study. It was the spark of an initial dinner-party encounter which launched the project: 'I knew that I wanted to follow Anna Brito's thought and work' (Goodfield 1982: 51). Keller had caught glimpses of McClintock around Cold Spring Harbor when the younger woman visited the laboratories there as a student in the 1960s and she was curious about McClintock's controversial scientific reputation. Keller writes of Barbara McClintock 'providing inspiration' (Keller 1983: xxv) and of a 'surprising warmth' and 'engaging ... personal exchange' (Keller 1983: 17) in her first interview with the scientist.

Like *The Double Helix*, all three of these books trace scientific discovery and document outstanding scientific achievement. Moreover, these authors convey a sense of mission regarding the standing of their subjects in their scientific communities. They claim to see what their subjects' scientific communities either had failed to see (Sayre), saw belatedly (Keller) or were yet to recognize (Goodfield). Their documentation thus helped secure their subjects' status within their scientific fields, as well as in a wider public context. Admiration for their subjects and high levels of identification are not uncommon amongst authors of biographies. Although, as Michael Shortland and Richard Yeo point out in a discussion of recent scientific biographers, such authors 'rarely explain[s] why a particular biography was written and why in a chosen style' (Shortland and Yeo 1996a: 31). The explicitness regarding intention and about personal bonds with their subjects are thus rather distinctive markers of these books.

While the early 1970s was the beginning of the age of the mass circulation paperback popular science text, biographies were firmly established as the best-selling non-fiction genre of the late twentieth century in North America and the United Kingdom. Second-wave feminism was a crucial factor sustaining ventures in women's scientific biographies. Feminists of this period were ambitious about the generation and circulation of stories of women's lives and eager to uncover the contribution of women in various spheres of culture. The feminist presses and women's bookshops which emerged in the late 1970s and 1980s in the United Kingdom, the United States and elsewhere catered to and fuelled the interest in women's stories. In this context, the documentation of scientific achievement undertaken by Sayre, Goodfield and Keller took on further significance, particularly given the chronic underestimation of women's contributions to the natural sciences. In fact, the ambition and significance of these cultural interventions were themselves symptomatic of that underestimation. Most biographical writing merely provides a gloss or fresh perspectives on the achievement and acknowledgement already accorded outstanding scientists. These books did more than this. The Franklin and McClintock biographies are linked to what Sandra Harding calls 'the "women worthies" project concerned with restoring and adding to the canons the voices of significant women in history' (Harding 1986: 30).

Women scientists: extraordinary lives

While Watson conjures the modern male scientist as an 'ordinary guy', particularly in relation to his sexual orientation and activities, these authors tell more complex stories of sacrifice, tension and denial, and of women who were continually cast as *extra*ordinary. In each of these studies the author suggests that her subject's entry into higher-level scientific education precipitated family conflict or withdrawal of support. Indeed, in setting out on a career in science each of the heroines is shown as defying gender conventions and expectations. Sayre indicates the ways in which Franklin broke with her family's expectations regarding young women's education and career trajectories. Indeed, Sayre provides a fairly detailed exposition of the elements of conventional femininity for women of Franklin's class in that period in Britain.[8] She outlines the ways in which Franklin deviated from these conventions in pursuing her career. Goodfield explains, in relation to Anna, that in Portugal 'at that time an only female child was expected to be a loving daughter, get married early, and produce grandchildren. She was not expected to become a medical doctor, reject her country, leave home and stay away' (Goodfield 1982: 7). Of course, such patterns of breaking with established trajectories were not atypical for young women from Britain, the United States and Portugal who entered science education in the early to middle decades of the twentieth century.

Keller presents McClintock as a figure who was clearly not ordinary in any of the ways Watson conjured. This is signalled in the introduction when Keller refers to McClintock's 'pursuit of a life in which "the matter of gender drops

away"' (Keller 1985: xxv). It is also apparent when reference is made to McClintock's 'wish to be free of the body' (Keller 1985: 36). Nevertheless, the explanations here and the subsequent unfolding of Keller's scientific career establish that she did invest extensively in physical observation and other corporeal activities. Keller demonstrates that this disavowal clearly pertains to McClintock's desire to throw off contemporary expectations about feminine appearance and conventions around gendered embodiment.

Women in science: heteronormative restrictions

James Watson exposed, enacted and celebrated the heterosexist gender dynamics that sustained his life in science and that of his male colleagues. It was only in the Epilogue to *The Double Helix*, which was a controversial apology for his negative portrayal of Rosalind Franklin that Watson reflected on the significance of these dynamics for female scientists. Here he refers to he and Crick 'realizing years too late the struggles that the intelligent woman faces to be accepted by a scientific world which often regards women as mere diversions from serious thinking' (Watson 1969: 133). Nevertheless, Watson had himself put into circulation a powerful popular narrative about modern science which effectively re-enacted precisely the kind of denigration of women he discussed in his Epilogue.

The three biographies considered in this chapter cast the gender relations of modern science in a very different light. They show that for these female scientists Western heterosexist normativity, far from facilitating their lives in science, produced tensions and conflict. These lives in science are shown to be built around confrontation and difficult negotiations with, rather than flamboyant enactments of, heterosexual norms and expectations. While Watson recounts how heterosexual conventions *support* male careers and creativity in science, the biographers of these female scientists show a very different set of dynamics. So, for example, Sayre contended that Franklin 'sacrificed' having children to facilitate her scientific career, explaining that '[t]his was what she gave up as the token and sign of her sincerity and her commitment' (Sayre 1975: 53–4).

While Goodfield quotes Anna rejecting Sayre's framing of female scientific life involving 'sacrifice', she indicates various turning points in Brito's 'life as a woman' (Goodfield 1982: 65), showing that this was often in tension with her life as a scientist. Indeed, Goodfield's (and Anna's) conceptualization of her 'life as a woman', as distinct from her 'life in science', contrasts sharply with Watson's representation of the smooth complementarity between sexual and scientific identities amongst his male scientific colleagues. In some instances Goodfield is explicit about resulting conflicts. For example, she recounts an early period of the scientist's career: 'It was a time of great tension. Anna was contemplating marriage and was generally expected to assume a woman's traditional role. The conflict between these claims and those of a concentrated scientific career strained her to the breaking point' (Goodfield 1982: 34). At other junctures she merely hints at tensions and difficulties, as when she quotes Anna as observing, in an important moment in her career, that 'many roads

have come to an end with my life as a woman too' (Goodfield 1982: 145). At another juncture Anna reflects:

> The woman in me wants to give up, but the total person I am is here, and rejoices in Michael's [a research colleague's] voice telling me that ferritin-positive cells and transferring-positive cells are in the thymus-dependent area of the lymphatic spleen.
>
> (Goodfield 1982: 152)

This splitting of Anna's identities as woman and as scientist is in stark contrast with Watson's vision of the enactment of masculine heroism in and through science. Keller explains that McClintock copes by withdrawing from the obvious conventions of femininity in the hope that ' the matter of gender' 'drops away' (Keller 1983: 26). In diverse ways, these biographies show, in contrast with Watson's story, that heterosexual norms did not work positively for twentieth-century women working as scientists.

Homosocial networks and female exclusion

The homosocial networks which sustained Watson and his colleagues and which were reinforced by institutional structures figure rather differently in these biographies of female scientists. Sayre shows in considerable detail the consequences of prohibitions about women's full participation in academic life at King's College London in the 1950s. She also indicates how more informal networks marginalized Rosalind Franklin as a female scientist (Sayre 1975: 98). She characterizes Franklin's experiences of these collegial limitations as a kind of 'purdah' (Sayre 1975: 97). Keller sketches the restrictions which, in the 1930s to 1950s in the USA, channelled McClintock and other women scientists away from research and high-level posts. In a chapter strikingly titled 'A Career for Women' (Keller 1983: ch. 4), she explains how McClintock encountered the traps and limitations of the gender segregation that operated in the natural sciences in mid-twentieth-century USA: 'women in the sciences tended to be scientific workers and teachers rather than scientists. ... Careers as research scientists were not available to them' (Keller 1983: 52). Although each of these authors shows their female subjects working effectively with other colleagues and students as well as becoming valued mentors, all three women emerge as relatively isolated and as marginalized in the male-dominated collegial networks of their scientific fields.[9]

Scientists and sexuality: 'men act and women appear' (Berger 1972: 47)

> To be the object of vision, rather than the 'modest,' self-invisible source of vision, is to be evacuated of agency.
>
> (Haraway 1997: 32)

While James Watson flaunts the sexual prowess of the men of science around him, it is striking that there is no explicit reference to sexual relationships in these accounts of the lives of these outstanding female scientists. Sayre notes that, during her visit to the USA in 1956, Rosalind Franklin 'met a man whom she might have loved, might have married' and that 'she put this out of her mind, but she went on living, fierce and even passionately' (Sayre 1975: 184). Goodfield (1982: 34) indicates that Brito considered marriage before embarking wholeheartedly on her career. In these stories of high-achieving twentieth-century women scientists, sexual frisson is not linked to scientific achievement and, in this respect, these women are cast as lonely figures. Whatever the nature of their actual lives, their sexual activities were not represented as relevant to or enhancing their scientific careers or status.

Watson's celebration of the sexual prowess of his male scientific colleagues contrasts sharply with Sayre's and Keller's accounts of the suspicion garnered about the femininity of Franklin and McClintock. They demonstrate that these scientists were continually subjected to the critical male gaze. Keller traces in the files of the Rockefeller Foundation (the most important US scientific funding agency in the twentieth century) a note written by a key administrator which records that 'Miss McClintock has a slight, boyish figure, weighing about 90 lbs., with a tousled boy's haircut' and 'that her father was so greatly disappointed that she was not a boy that he proceeded to raise her as a boy'. This note summarily concluded: 'And she still looks and acts more boy than girl' (Keller 1983: 75). As noted previously, Sayre registered the creation of what she regarded as the fictional character 'Rosy'. Watson's character was, in Sayre's estimation, 'the perfect, unadulterated stereotype of the unattractive, dowdy, rigid, aggressive, overbearing, steely, "unfeminine" bluestocking, the female grotesque' (Sayre 1975: 19). She continued: 'By choice, he tells us, she refuses to emphasize her feminine qualities – by which he means (and it is his idea of femininity) that she is badly dressed, wears no lipstick, does nothing interesting with her straight black hair' (Sayre 1975: 21).

Sayre and Keller tackle these negative appraisals in rather different ways. Nevertheless, they both offer more positive assessments of these scientists' appearance. Sayre contests Watson's version of Franklin as a distortion and she rebuts specific elements of his portrait: 'People with whom Rosalind worked in both England and in France thought her rather smart, always well-groomed, discernibly English in her style, but far from habitually dowdy'. Moreover, she contends that 'the lipstick was almost invariably there' and that Franklin did not ever wear spectacles, explaining: 'Rosalind had the eyesight of an eagle, and resorted to magnifying lenses only for the closest of fine work' (Sayre 1975: 21). Indeed, Sayre's efforts to document evidence of Franklin's femininity were extensive and disturbed at least one of the reviewers of this book.[10] Keller, by contrast, does not directly contest the appraisals of McClintock's appearance as unfeminine. Instead, she makes this a matter of individual style, giving it a positive gloss by attributing it to a distinctive personal, aesthetic orientation. She notes:

> Her slacks and shirt pointedly rejected feminine fashion, but they were carefully pressed. The economy of her words and movements, the way she dressed, the way she moved and talked – all expressed a fastidious spareness, an aesthetic of order and functionality.
>
> (Keller 1985: 17)

These contestations draw attention to the ways in which the ubiquitous evaluations associated with the male gaze were enacted with distinct consequences for twentieth-century female scientists. Moreover, these authors demonstrate that they were aware that the focus on appearance detracted attention from the scientific activities of these women. They take issue with negative appraisals in quite different ways: Sayre assembling evidence of Franklin's feminine appearance to discredit Watson's description; Keller following McClintock's lead in eschewing any reference to gender by emphasizing her androgynous 'aesthetic of order and functionality' (Keller 1983: 17). Nevertheless, these reassessments of appearance and sartorial tastes themselves enact the very modes of appraisal that were a crucial and problematic part of the intensely binarized, heterosexist regimes of the scientific worlds their subjects inhabited.

The threat of feminism

Watson's reported reappraisal of Sayre when she accepted the double-helix hypothesis was stark: she had proven that she was a good scientist rather than a feminist. In *The Double Helix* feminism was presented as threatening Watson and his colleagues, and the very activity of science itself, although Watson never explains *why* he finds it so menacing. This construal of the relationship between science and feminism casts its shadow over the three biographies considered in this chapter. On the one hand, all three biographers register the gender inequalities they have observed in the world of science and its consequences for their subjects. Nevertheless, they also demonstrate that these scientists were *not* feminists.

Sayre traced what she considered to be the mistaken identification of Franklin with feminism. According to Sayre, this begins with Franklin's PhD supervisor, R. G. W. Norrish, and recurs most persistently in Watson's portrayal of her as a 'bluestocking'. In dismissing Norrish's perception of Franklin, Sayre insists that the female scientist was '"[f]eminist"only in the widest philosophical sense, not in an activist one' and that her position 'had little in common with doctrinaire, or political, feminism ... for the simple reason that it was not fundamentally feminist' (Sayre 1975: 58–9). Instead, Sayre noted that Franklin displayed an 'attitude ... of exacting professionalism' (Sayre 1975: 59). Somewhat contradictorily, in the 'Afterword' of the book, Sayre does express concern that Franklin 'had been taken up, in the Watson version, by antifeminists everywhere' (Sayre 1975: 197).

There is only one direct reference to feminism in Goodfield's book, despite the accounts of the tensions precipitated in Anna's 'life as a woman' by her life

as a leading-edge scientist. At one point, Anna reflects: 'Mine is the eternal problem of women in science. Very, very few women bring this off. But it is our own choice; it is self-inflicted.' She then reassesses the gender specificity of her situation:

> This is, of course, the eternal problem of anyone in science. It yields its secrets only to single-minded obsession, and at the end of the lonely day, the week, the year, or the decade one emerges from the laboratory into what, humanly speaking, is a very empty space.
>
> (Goodfield 1982: 149)

In her final musings about scientific creativity, Anna is reported as recalling a revealing episode in which she was perceived to be a feminist. She reflects that

> the conception of a concept, or the gestation of an idea, is really a kind of birth. It is the only time when men can share with women an essentially female experience; the only time when a man can experience anything like giving birth.
>
> (Goodfield 1982: 230)

She states that she 'said this to a man in England, he was frightened ... or annoyed. He thought I was saying it for feminist reasons. But I wasn't' (Goodfield 1982: 230). Here Brito rehearses the argument which emerged in feminist and critical science studies scholarship of the 1980s (Easlea 1980a, 1983; Merchant 1980)[11] that scientific creativity was, in some ways, a substitute for feminine reproductive creativity. However, she quickly denies any feminist intentions or identity, disavowing the feminist connotations of her framing of science.

In the foreword to Keller's book, Rollin Hotchkiss declared that as 'a humanist, rather than a feminist' McClintock 'expected unprejudiced respect for herself and other women' (Keller 1983: xiii). In the acknowledgements, Keller puts great store in McClintock's 'rejection of female stereotypes' and the 'pursuit of a life in which "the matter of gender drops away"' (Keller 1983: xxv). She explains that

> she was adamant; she was too different, too anomalous, too much of a 'maverick' to be of any conceivable use to other women. She had never married, she had not, as an adult or as a child, ever pursued any of the goals that were conventional for women. She had never had any interest in what she called 'decorating the torso'.
>
> (Keller 1983: 17)

She notes that McClintock 'had come to insist on her right to be evaluated by the very same standards as her male colleagues' (Keller 1983: 76–7).

In a later important reflection on gender relations in science in the USA in the twentieth century, Evelyn Fox Keller observed:

> Throughout this [the twentieth] century, the principal strategy employed by women seeking entrance to the world of science has been premised on the repudiation of gender as a significant variable for scientific productivity. The reasons for this strategy are clear enough: experience had demonstrated all too fully that any acknowledgement of gender-based difference was almost invariably employed as a justification for exclusion. Either it was used to exclude them from science, or to brand them as 'not-women' – in practice, usually both at the same time. For women scientists *as scientists*, the principal point is that measures of scientific performance admitted of only a single scale, according to which, to be different was to be lesser. Under such circumstances, the hope of equity, indeed, the very concept of equity, appeared – as it still appears – to depend on the disavowal of difference.
>
> (Keller 1999: 236)

Keller's observation resonates with the accounts of the lives in science registered in these books. There is ample evidence provided to indicate that each of these scientists repudiated gender 'as a significant variable for scientific productivity'. Sayre asserts that Franklin operated with the 'assumption that rational people would easily understand without further demonstration that she deserved to be judged not as a woman scientist, but as a scientist pure and simple' (Sayre 1975: 54). Keller contends that McClintock wished 'to transcend gender altogether' (Keller 1983: 76) and that, as her career developed, '[i]n effect, she was refusing to accept a woman's place. ... She had come to insist on her right to be evaluated by the very same standards as her male colleagues' (Keller 1983: 76–7). Anna repeatedly rejects contentions that gender mattered in science. She regards Sayre's account of Franklin 'sacrificing' children for her career as a distortion (Goodfield 1982: 65) and she quickly reframes her own construction of 'the eternal problem of women in science' as 'the eternal problem of *anyone* in science' (Goodfield 1982: 149).

Nevertheless, as Keller and the other authors of these biographies clearly establish, 'the matter of gender' did *not* 'drop away' and these books demonstrate why it mattered in these women's lives in science. These texts have been written in the wake of second-wave feminism and, in different ways, the authors were influenced by this movement. They offer observations of gender divisions, inequalities and forms of discrimination with which each of these female scientists contended. Keller observes that McClintock learned that '[n]o efforts of her own would erase the fact that she was a woman in a profession institutionally established for men' (Keller 1983: 76). Summing up Franklin's career, Sayre concludes: 'She was a very good scientist and a very productive one, a very honest one of unimpeachable integrity'. Alluding to the problems gender relations had created for Franklin (which she delineates in the book), she then interjects: 'she was not the less of any of these things because she was a woman, and often opposed on no better grounds than her sex' (Sayre 1975: 197). Although Goodfield does not explicitly highlight specific gender barriers inhibiting Anna once she embarks on her career, as noted previously, she does

expose the tensions Anna experienced between her life as a woman and her life as a scientist.

The long quotation from Keller given above suggests that in the twentieth century female scientists were likely to be regarded as suspect both as scientists and as women. While these three popular texts on women's lives in science are primarily oriented towards convincing a wide public readership that their subjects had made important contributions to the twentieth-century biosciences, they manifest an awareness of the double scrutiny to which these women had been subjected. Nevertheless, they dispute (Sayre 1975) or contain (Keller 1983) previous deprecating assessments of these scientists' unfeminine appearance. In addition, both Sayre (1975) and Goodfield (1982) provide evidence of their subjects' heterosexual credentials through reference to marriage possibilities. Hence, whilst contesting some specific evaluations, in effect they reinstantiate the dual assessment mechanisms which circumscribed the lives of women scientists during this period.

For Watson, the feminist was the figure who posed the greatest threat to science. Not surprisingly, these accounts of women's scientific achievement, which followed in wake of *The Double Helix*, trod cautiously around issues of both femininity and feminism. Feminism is a spectral presence in all of these texts: as I have indicated, it figures explicitly almost exclusively in disavowals and distancing. Yet the terms of reference and interpretation deriving from second-wave feminism inform these representations of women's lives in science. Moreover, it was the late twentieth-century Western feminist interest in 'women worthies' and in rewriting the canon of Western cultural achievement which helped to create an enthusiastic readership for these texts. Nevertheless, it was only with the appearance of Donna Haraway's *Primate Visions* (1989: esp. 277–367) that feminism came fully out of its scientific closet. Haraway's analysis of the making of primatology as a new science of the twentieth century presented profiles of four 'North American white women' (Haraway 1989: 303) scientific heroes openly working at 'the intersection of feminism and the science of monkeys and apes since about 1970' (Haraway 1989: 285–6).

Out of the race: doing careful science

The four books considered in this chapter provide narratives of discovery. In each case, the scientific discovery (of the double helix in Watson's and Sayre's texts, of the behaviour of lymphs in cancer in Goodfield's, of gene transposition in Keller's) is the fulcrum for and climax of the life-story presented therein. In this sense, they are conventional stories of scientific heroism.[12] In Watson's case, the achievements associated with the discovery of the double helix had already been celebrated through the award of the Nobel Prize in 1962. Thus, the book provided a retrospective account of the activities through which he (and Crick) had 'earned' this prestigious international commendation. The exclusive focus on this episode, without reference to the preceding history of genetics or to subsequent developments in the period between 1953 and the publication of

Watson's book in 1968, contributes further to the heroic casting of Watson and Crick (Van Dijck 1998: 38–45). The narratives of discovery which Sayre, Keller and Goodfield constructed did not have such firm cultural underpinning. These authors had to establish their claims regarding heroic accomplishment without the benefit of preceding public cultural legitimation.[13] In addition, Sayre and Keller tried to address and dispel negative images that had accrued to their subjects within their scientists' own research communities. More generally, these three biographies demonstrated to a wide reading public that these figures merit international renown.

These claims for scientific heroism, through tales of discovery, also incorporated explorations and contestations concerning how science could and should be done. As I have indicated previously, Watson's was an irreverent account which highlighted masculine camaraderie, competition, flashy insight and happenstance, although model building was the scientific method which was lauded in his story. The three biographies presented in this chapter offer very different visions of the *doing* of science, explicitly or implicitly contesting Watson's vision of racy science.

Sayre took direct issue with many aspects of Watson's picture of scientific research, which she feared would be excessively influential because of the popularity of *The Double Helix*. She contrasted Franklin's systemic crystallographic approach to the investigation of DNA with Watson's impulsive model building, asserting the importance of traditional empirical methods and objective reasoning (Sayre 1975: 146) in science. However, methodological issues were not her only concern in relation to the doing of science. She raised questions about ethical codes of conduct pertaining to the ownership and circulation of research materials and findings. Moreover, she expressed her scepticism about the ethos of racing, suggesting that, in accordance with her image of Franklin, good scientific research required slow, careful observation and experimentation.

The prologue of *An Imagined World* consists of one of Anna's letters laying out the domestic detail ('a corridor of smells ... cages of mice ... surgical instruments ... petri dishes ... sterile bottles of medium') of her laboratory, with her declaration: 'this is what science is made of'. This image and declaration convey a starkly different orientation to scientific research to that provided in Watson's narrative. The text enacts an ongoing dialogue between Brito and Goodfield about scientific research in which Brito repeatedly rejects Goodfield's textbook history and conventional philosophy of science vision of how science works. The scientist insists on the network of agents and elements involved in the making of science. The human dimension of such networks which is foregrounded is teamwork, which for Brito also included the contributions of technicians and cleaners. Information about the economic and bureaucratic structuring of research science peppers the account, particularly when Anna is shown struggling with the constraints of the US research grant system.

While Brito's extended and rather domesticated model of scientific creativity is fully registered, the text is also shaped by Goodfield's interest in the psychology of outstanding individual scientists. The discussions and arguments recounted in

the book carve out a model of personal motivation in scientific investigation that is far removed from Watson's picture of male bonding through competition. Anna contends that 'the best analogy' for scientific research 'is always love – making love' (Goodfield 1982: 69). Parallels are established between artistic and scientific creativity, through Anna's wide-ranging high-cultural references to visual artists, musicians and poets. Beyond this, she insists that empathetic identification with elements of the natural world sustains good scientific research, commenting: 'If you really want to understand about a tumor, you've got to *be* a tumor' (Goodfield 1982: 226).

Keller (1983: 207) quotes this guideline, thereby establishing the affinity between the Portuguese researcher and McClintock in their orientation to scientific research. Keller documents McClintock's years of dedicated observational research and emphasizes that the cyto-geneticist cultivated and was sustained by her 'feeling for the organism'. As Keller (1989) emphasized in a later commentary about this biography, she makes the case for the enrichment of science through diversity in methodological and personal approaches through McClintock's story. Hence, McClintock's 'naturalist's approach' (Keller 1983: 207) is posed as unsettling the hegemony of the structural, molecular biology which had been instantiated, in part, through Watson's tale of the revelation of the double-helix structure of DNA. Similarly, Keller's observation that, for McClintock, 'years of close association with the organism she studies, is a prerequisite for her extraordinary perspicacity' (Keller 1983: 198) indicates that the pace of scientific achievement may be far slower than Watson's memoir suggests. Here and in her elaboration about McClintock's mystical engagement with the natural world she emphasizes the bonding between scientist and nature, rather than the collegial male bonding which Watson celebrates as a feature of leading-edge scientific research.

Receptions and refractions: up close and personal

The conjurings of scientific heroes reviewed in this chapter were highly personalized projects through which each of these authors established the position of their subjects in their scientific communities while seeking to enlighten a broad lay readership about how science works. These authors claim insider status: Watson as one of the main actors in the discovery of the structure of DNA; Sayre as a close friend and wife of one of Franklin's colleagues; Keller as a former scientist and historian of science; and Goodfield as an established historian of science and a science journalist.[14] As previously indicated, strong personal bonds between the authors and their subjects characterized and sustained the biographies of women scientists analysed in this chapter.

However, by the time Evelyn Fox Keller's biography of McClintock appeared in 1983 a new professional social studies of science was making its mark by offering new kinds of 'laboratory lives'. The latter term is an adaptation of the title of Bruno Latour and Steve Woolgar's influential study (*Laboratory Life: the social construction of scientific facts*, 1979),[15] which was one of the first and most

lauded in this cluster of ethnographically based studies that came to characterize a powerful strand of social studies of science.[16] Anthropological in orientation, the authors of these books entered their field (laboratories) and studied the 'native tribes' (as they sometimes labelled them) and practices therein by rendering them strange and foreign. Suspicious of biographical accounts, heroic discovery narratives and other humanist tropes, these scholars generally produced abstracted, detached analyses of scientific work that decentred human agency. Their relationship to the kinds of projects analysed in this chapter is exemplified in Latour and Woolgar's dismissive characterization of Goodfield's *An Imagined World* as a 'detailed study of an individual scientist's experiences, . . . which fails to address the social process of laboratory work' (Latour and Woolgar 1986: 285, n.4.).

However, while they were determinately uninterested in the personal, these new social studies of science researchers did seek to position themselves close to canonical sites in the making of science – laboratories. Strikingly, their selection of other resources to bolster their studies resulted in some strange judgements. For example, Latour and Woolgar treat *The Double Helix* as a premier resource for their sociological analyses, one that they consider is not mired by the psychological preoccupations and humanist myth-making they seek to avoid. Citing a particular incident in Watson's narrative, they explain that

> Watson's portrayal of his 'pretty model,' in which bases are paired along a like-with-like structure, does not situate himself in a realm of thought, but inside a real Cambridge office manipulating physically real cardboard models of the bases. He does not report having ideas, but instead emphasises that he shared an office with Jerry Donohue. . . . If Watson had not written his book, no doubt the complexity of this practice would have been transformed, either into an anecdote that 'one day Watson got the idea of trying the keto form' or into a titanic epistemological battle between rival theories.
>
> (Latour and Woolgar 1986: 171–2)

This appraisal of *The Double Helix* as providing an untainted, non-idealized, materialist account of science in the making is elaborated in Latour's *Science in Action: how to follow scientists and engineers through society* (1987). In this book, Watson's highly personal memoir is treated as a primary source and reference text in Latour's mapping of strategies appropriate to the new social studies of science. In treating Watson's text as an unmediated account of science (as showing how it *really* works), Latour and Woolgar failed to acknowledge the ways in which *The Double Helix* performatively enacted its own mythical version of scientific achievement.

The biographies of women scientists examined in this chapter found a more receptive readership outside the developing professional science studies community. One reviewer noted that Keller's biography of McClintock '[u]nderstandably . . . became something of an inspiration for women working within science and technology, feminists and non-feminists alike' (Grobicki 1987: 211). As noted

previously, auto/biography was a generic mainstay of second-wave feminism and the pursuit of 'women worthies' (Harding 1986: 30) was a crucial strategy in the challenging of established canons in all Western cultural fields. These accounts of lives in science were attractive to feminists involved in a social/political movement that took as its touchstone the slogan that 'the personal is political'. Moreover, a new feminist science studies was emerging as an interdisciplinary academic field during this period, including among its key figures Donna Haraway (1985), Sandra Harding (1986) and, indeed, Evelyn Fox Keller (1985) herself. Nevertheless, some feminist reviewers were dissatisfied with these biographies because they felt they did not offer sustained critical perspectives on science and gender norms (Hubbard 1976; Grobicki 1987). In addition, the biographies examined in this chapter intersected with two key foci of feminist controversy during this period which revolved around the possibility of distinctive women-centred or feminist forms of culture. These were debates about an identifiably feminine or feminist ethics of care[17] and about the prospects for a distinctive feminine or feminist science.

In 1991, Sandra Harding observed: 'the question "Can there be a feminist science?" has been raised by virtually everyone who participates in or contemplates the feminist discussions of the sciences' (Harding 1991: 296).[18] This preoccupation undoubtedly influenced some readings of the popular biographies of women scientists analysed in this chapter. Indeed, Evelyn Fox Keller explicitly entered into the debate about a 'feminist science' in the wake of responses to her biography of McClintock. Keller disabused interpretations of McClintock as the harbinger of a distinctive feminine or feminist science on a number of grounds, including that '[t]o ask women scientists to accept the notion of a different science representing a different reality ... would be to ask them to give up their identity as scientists' and that this would 'reinforce the traditional opposition between women and science' (Keller 1999: 240).

Nevertheless, Keller was subsequently charged by the science studies scholars Evelleen Richards and John Schuster (1989a, 1989b) with both advocating a feminist science and uncritically employing a methods discourse. Taking Keller's representation of McClintock's scientific practice and Sayre's account of Franklin's mode of scientific research as their main case studies, Richards and Schuster rehearsed the claims for 'social constructivist and contextualist analyses of scientific practice' (Richards and Schuster 1989b: 729) which they endorsed as preferable to 'the story of invention, refinement and deployment of the method' (Richards and Schuster 1989b: 727). The focus of the dispute between Keller and Richards and Schuster was the status of methods discourse, with Keller claiming its importance for scientific research and Richards and Schuster maintaining that it rhetorically glossed the actual activities of science, yielding only a mythical version of such research.

The laboratory studies of Latour and Woolgar and other ethnographers of the 1980s and the heated exchanges between Keller and Richards and Schuster were harbingers of the burgeoning new social studies of science. This new disciplinary field was forged through the development of distinctive anthropological

modes of analysis and through critical renunciations of some traditional tropes of the history and philosophy of science. Rejection of humanist frameworks manifested in preoccupation with the scientific mind and individual scientists and of methods discourse were some of the key markers of this new 'post-Kuhnian' (Richards and Schuster 1989b) science studies.

The excitement around these innovations masked some conservative features of this new orientation in science studies. First, there was a reverential celebration of the laboratory which was treated as the main location for the making of science.[19] Second, in some of this work there was a tendency to identify and interrogate only *certain* forms of myth-making in accounts of scientific research (as Latour and Woolgar's 1986 uncritical use of *The Double Helix* illustrates). Third, the new orientation was manifested in a reluctance to discuss issues which pertained to more macro features of science as a social activity. The most obvious instance of this last pattern was the neglect of attention to the gender relations of science and the consequent failure to investigate the production and reproduction of science (at its highest levels) as 'a world without women' (Noble 1992; Haraway 1997). The abandonment of humanist approaches did yield a more complex, less anthropocentric picture of agency in the making of science. However, there was little incentive to develop more sophisticated understandings of human agency in scientific development.[20] Finally, the preoccupation with traditional sites and locations meant that the new social studies of science never fully acknowledged the diffused and multiple locations in which science was made.[21] In this sense, it was largely disconnected from the new sub-field of public understanding of science which emerged in the 1990s and which lacked the theoretical sophistication of its sister field.[22]

Meanwhile, as Christopher Frayling has recently argued, in the context of his review of cinematic representations of scientists, 'in the *public* rhetoric of science, biography is still as important as it has ever been' (Frayling 2005: 179). This chapter has analysed a crucial phase in the making of the modern scientific hero. It has traced the emergence of a new secular vision of the heroic scientist in the most popular scientific memoir of the twentieth century, *The Double Helix* (1968), which celebrated the heteronormative framing of science. Through the figure of Watson a distinctive set of tropes was established: the heroic scientist was an ordinary guy, competitive and racing, and profoundly threatened by feminism. The popular biographies of women scientists considered here take their cues from this new figuration of scientific heroism. They show extraordinary women, rather than the ordinary guy, and the other – troubled – side of the heteronormative conventions which Watson celebrated. They also describe diverse modes of and paces for doing outstanding science. Feminism was a crucial resource in the construction of these 'women worthies', yet it was kept at a distance. Meanwhile, a new social studies of science was forged with and against these popular books, while the new sub-field of public understanding of science emerged as a distinctive research as well as policy field.

Steven Shapin and Simon Schaffer's important science studies text *Leviathan and the Air-Pump: Hobbes, Boyle and the experimental life* (1985) conjured the figure of

the scientific witness as the legitimated agent in the making of the modern experimental sciences. They trace the historical circumstances for the emergence of this figure in the social and political culture of seventeenth-century England. As they explain, science required 'a *modest man*' 'whose narratives could be credited as mirrors of reality ... his reports ought to make that modesty visible' (Shapin and Schaffer 1985: 65). Donna Haraway (1997) has, in turn, interrogated Shapin and Schaffer's own conjuring, recasting their study as an investigation, not only of the making of modern science, but also of the making of modern gender relations.[23]

Haraway maintains that there have been 'practical inheritances which have undergone many reconfigurations but which remain potent' from Boyle's version of the 'modest witness' and that 'the important practice of credible witnessing is still at stake' (Haraway 1997: 33) in contemporary science. The analysis of twentieth-century heroes of science offered in this chapter provides some perspective on twentieth-century reconfigurations of this model of scientific heroism. In fact, the furore surrounding the publication of *The Double Helix* (Stent 1980a) may have indicated fears that this idealized model of how science works would be undermined by the circulation of Watson's narrative. The contention of this chapter is that Watson's text does not banish the figure of 'the modest witness'; rather it offers a new alignment of heterosexual masculinity and scientific prowess a new twentieth-century model of the heterosexist, virile 'modest witness'.

In contrast, the tales of lives lived in and through twentieth-century science reviewed in this chapter show the difficulties European and North American women encountered when they claimed to be 'objective, modest witnesses to the world' (Haraway 1997: 32). Some two centuries after Boyle's establishment of the social technology for experimental philosophy, in Europe and North America science was, indeed, more open to women (Rossiter 1982, 1995). The female scientific heroes of this chapter had gained high-level scientific education and, as qualified and accomplished working scientists, they were *positioned* as 'modest witnesses'. Nevertheless, they were repeatedly subjected to two forms of delegitimizing ploy. Brought under the scrutiny of the male gaze, they were made 'the object of vision' in ways that undermined their claims to be 'the "modest," self-invisible source of visions' (Haraway 1997: 32). In addition, the label 'feminist' was mobilized as a powerful disqualifying epithet – which proclaimed political perspective, rather than objective witnessing. These were the modes through which individual twentieth-century female scientists were delegitimized as scientific witnesses, despite their being highly professionally qualified and accomplished working scientists.

These popular biographies of scientists explored the 'critical boundary between watching and witnessing, between who is a scientist and who is not, and between popular culture and scientific fact' in the twentieth century (Haraway 1997: 33). While they tell very distinctive stories, the heroes of these tales are each cast with reference to two spectral figures – the feminist and 'the modest witness'. Watson vividly and insistently portrays these figures as antithetical. Against this background, and as explained on pp. 57–60, in the other texts considered here disabusing the label of feminist becomes a crucial element in sustaining claims regarding the scientific heroism of these twentieth-century women.

Although the hero of *The Double Helix* was a far cry from 'Boyle's celibate, sacred-secular, and non-marital man', he still claimed Boyle's legacy as 'a modest witness ... of the mind' (Haraway 1997: 32). The heteronormative and homosocial scaffolding of twentieth-century science were foregrounded and celebrated in Watson's tale of scientific achievement. His twentieth-century scientific hero was much more overtly and aggressively heterosexist and masculine than his seventeenth-century predecessor. Strikingly and somewhat ironically, the watchword that seems to dominate of the stories of Franklin, McClintock and Brito considered here is also modesty. However, these are tales of far more pervasive modesty – identified with these women's bodies, their aesthetics, their dealings with others, as well as with their personal styles in doing science. These biographies have been written with a great deal of passion and, on one level, this almost excessive emphasis on modesty may be indicative of these authors' efforts to gain cultural legitimacy for their subjects. Beyond this, it is also a reminder of the considerable work (including symbolic work) required in order to make women and persons of colour 'count as objective, modest witnesses to the world' (Haraway 1997: 32).

A postscript: 'post-feminist' recastings of scientific heroism

As the preceding analysis suggests, feminism was the ghostly presence which haunted, informed and sustained the biographical projects of Sayre, Goodfield and Keller. Rosalind Franklin and Barbara McClintock became heroines of second-wave feminism. Early in the twenty-first century, new biographies of both of these scientists appeared. Nathaniel Comfort (2001) took issue with many aspects of Keller's account; in particular, he questioned the portrayal of McClintock as a scientific outsider who had been kept at the margins of the scientific establishment. Comfort contends that Keller's reliance on interviews with McClintock and on a set repertoire of stories from the scientist produce a misleading picture which renders McClintock a victim rather than, as he presents her, as a main player in the history of genetics (Delamont 2005: 494–5). Brenda Maddox's (2002) volume, in contrast with Sayre's biography, offers a much more dispassionate account of Rosalind Franklin's life. The later biographer is much more matter of fact about Franklin's achievements, her personal strengths and weaknesses, and her sexual activities.

These are revisionist recastings that render McClintock and Franklin scientific heroes for the twenty-first century. Although a more detailed comparison would be required to detail the differences between the late twentieth- and early twenty-first-century versions of these scientific heroes, it is striking that these new biographies tell biographical stories in which the struggles and difficulties associated with gender are denied or contained. While feminism haunted the accounts of the lives of scientists analysed in this chapter, it is effectively banished in these revisionist versions.

campaigns, including the anti-nuclear movement, HIV/AIDS activism and the ecology movement.

8 See, especially, 'Part Three: Science and technology', in Franklin *et al.* 1991b: 127–218; and ch. 7, 'Technologies of the body', in Thornham 2000: 155–83.

9 Haraway (1997: 280, n.1) also mentions Paul Rabinow's discussion of this term and his linking of it to Heidegger's perceptions of technicity: the transformation of the entire world into a set of resources which are to be exploited.

2 Feminist cultural studies of science and technology

1 For a mapping of these, see Lykke 2002, forthcoming.

2 For example, some of the work of Constance Penley, Andrew Ross and Sarah Franklin blends elements of the traditions of cultural anthropology with those of British feminist cultural studies.

3 Although, as Constance Penley and Andrew Ross (1991a) have argued, there are strands of postmodernist theory which are uncritically celebratory in their attitudes towards technology.

4 The list of feminist-influenced science fiction writers of this period is extensive and would include, to name but a few key figures: Margaret Atwood, Marion Zimmer Bradley, Olivia Butler, Suzy McKee Charnas, Zoe Fairbairns, Sally Miller Gearhart, Ursula Le Guin, Anne McCaffrey, Vonda McIntyre, Naomi Mitchison, Marge Piercy, Joanna Russ, Pamela Sargent and James Tiptree Jr.

5 Hilary Rose (1994: 209) nominates, rather than Mary Shelley, Margaret Cavendish, the seventeenth-century English philosopher, duchess and author of the utopia *The Description of the New World Called the Blazing World* (1688), as the original 'foremother' of science fiction.

6 The *Reload* collection is particularly concerned with cyberfiction. The introduction to the volume (Booth and Flanagan 2002) and the chapters by Booth (2002) and Hollinger (2002) provide valuable reviews of and fresh perspectives on cyberfiction and feminist and queer science fiction more generally. Another interesting edited volume (Larbalestier 2006) contains a collection of eleven feminist science fiction stories and individual commentaries on each of them.

3 Newton as national hero

1 See Haynes 1994 (ch. 4), who also reviews some of the representations of Newton in eighteenth-century poetry.

2 Beaven's *Newton's Niece* (1994) imaginatively explores attributions regarding Newton's sexuality, including voyeurism and homosexuality, while foregrounding the scientist's niece, Catherine (Kit). *The Newton Letter* (Banville 1999) is a novel about an historian of science undertaking research on Newton.

3 In fact, it was one of the group Yeo studies, William Whewell, who first coined the term 'scientist', in 1833.

4 On the use of case studies in recent forms of social studies of science, particularly Actor Network Theory, see Erickson 2005: 82–5. He explains that '[t]o achieve its aims, actor-network theory proceeds by identifying case studies of interest, and then investigating the network of relations that emerge from given situations' (Erickson 2005: 82). Both Lauren Berlant (1997) and Lynne Pearce (2004) discuss the shift from textual analysis to 'case studies' in literary-oriented cultural studies work. Berlant notes that the term 'case study' seems more appropriate than 'text' to denote the sorts of analyses she undertakes, which focus on literary and filmic texts, as well as cultural events (see Berlant 1997: 11–15). See also Pearce 2004: 218, fn.6.

5 Jordanova contends that

> These cultural associations between science, medicine and nationhood were forged by two related processes. First, practitioners of science and medicine actively built imagined communities for themselves, which were based, more or less, on national boundaries. . . . Second, practitioners identified both themselves as individuals and their communities as collectivities with a relevant nation.
>
> (Jordanova 1998: 197–8)

4 Making twentieth-century scientific heroes

1 Anna modifies Watson's framework of 'winners' and 'losers' to include 'competitors' (Goodfield 1982: 212). She wonders if he or Crick ever get depressed (Goodfield 1982: 59).

2 For an analysis of the history of cinematic representations of scientists as bad, mad or dangerous, see Frayling 2005.

3 There was some concern that the mores and ethics displayed in Watson's account would cast science in an unfavourable light. See Sayre 1975: esp. 195; Stent 1980b; Yoxen 1985.

4 Through part of the book Maurice Wilkins looms as a rival but he is presented as a rather subdued one who is easily transposed into a collaborator.

5 There is a very brief reference to Watson's meeting with Dorothy Hodgkin, the British crystallographer, who would become a member of the Royal Society (Watson 1969: 54). However, there is no account of her work in the text.

6 It should be noted that both June Goodfield and Evelyn Fox Keller were themselves accomplished scientists. Keller has written about her own life as a scientist in a collection of articles in which feminists reflect about their work lives (Keller 1977).

7 For a discussion of the gender divisions and relations of science during this period, see Rossiter 1982, 1995; Abir-Am and Outram 1989; H. Rose 1994.

8 Sayre does not say much about Franklin's Jewish background. This looms larger in Brenda Maddox's (2002) more recent biography of Franklin.

9 This is not to say that these scientists were not shown as having good collegial relations. Sayre and Brito are portrayed as engaging in extended positive collaborations. While McClintock is shown as a rather lone researcher, her mentoring skills are also demonstrated in Keller's account. In all cases, it is striking that these collaborations are generally with those who are either juniors in the scientific hierarchy and/or social outsiders in the world of science because of their gender or national identities. For example, Anna's collaborators in the United States are almost exclusively foreigners. For a discussion of Goodfield's failure to reflect on this aspect of Brito's career, see Abir-Am 1982: 2.

10 Hubbard complains that 'the book devotes too much time to defending Franklin's "femininity" in the traditional sense of the word, but that is a matter of taste' (Hubbard 1976: 236).

11 For a psychoanalytical perspective on these issues, developed with reference to the history of molecular biology, see Keller 1992.

12 In fact, Evelleen Richards and John Schuster (1989a) criticized Keller for being conservative in adhering to a conventional narrative of scientific discovery.

13 McClintock was awarded a Nobel Prize shortly after the publication of Keller's biography.

14 Each of the authors of the biographies employs specific methodological techniques to facilitate her biographical studies. Sayer's access to Franklin's papers and to interviews with Franklin's colleagues, Keller's interviews with the reclusive McClintock and Goodfield's quasi-ethnographic methods, which include observations, interviews, letters and telephone conversations, are all invoked to underscore the accuracy of their pictures of both the scientist and the scientific world she inhabited.

15 This was the title of the first edition of this book. The second edition, published in 1986, appeared under the title: *Laboratory Life: the construction of scientific facts*. The authors explained the reasons for this alteration in the 'Postscript to the Second Edition' (Latour and Woolgar 1986: 281).

16 For a list of the main 'laboratory studies' which had appeared up to 1986, see Latour and Woolgar 1986: 285, n.4.

17 Carol Gilligan's (1982) contestation of Lawrence Kohlberg's theory of moral development provided the original framing for the notion of a distinctively feminine 'ethics of care' – the idea that women, in contrast to men, develop a moral sensibility through their investments in relationships. Gilligan's ideas were extremely influential, particularly within feminist scholarship in the late twentieth century. However, there was also notable critical response to Gilligan's work. One nub of controversy revolved around the nature of the bond between women and care. Questions were raised about whether this was an essentialist – a 'natural' – bond, an acquired characteristic or a problematic symptom of female oppression.

18 See Harding's long note of references supporting her claim (Harding 1991: 296, n.1).

19 The wave of laboratory studies in the late 1970s and early 1980s and his own research on Pasteur informed Latour's (1983) declarations that laboratory studies afforded understandings of the social and political specificities of science which challenged the distinction between 'micro' and 'macro', 'internalist' and 'externalist' science studies, and the 'inside' and 'outside' of science. While Latour's insistence that the laboratory was never 'immune from social forces' (Latour 1983: 156) was important, as the title of his 1983 article suggests ('Give me a laboratory and I will raise the world'), his preoccupation with the laboratory as the paramount site of science deflected attention from other locations and agents in the making of science. Latour subsequently raised critical questions about the assumptions which informed such laboratory studies when he commented that 'the main limitation of laboratory studies including my own' was that

> They start out from a place without asking if this place has any relevance at all and without describing how it becomes relevant. In only a very few cases are laboratories the place to start with if we wish to see science in the making.
>
> (Latour 1988: 261, fn.15).

20 See Keller's (1992) own attempt to pursue a psychosocial analysis of science.

21 Actor Network Theory explicitly addressed the complexity of the making of science. A key element in this was giving more attention to non-human actors. This orientation was linked to scepticism about the attribution of agency to scientific heroes. Latour's study of *The Pasteurization of France* (1988) provides a new architecture for conceptualizing the French national scientific hero which deconstructs Pasteur's agency and heroism. For another study of a more recent scientific hero, Stephen Hawking, see Mialet 1999.

22 Public understanding of science (PUS) is a complex field involving both policy makers and academics, particularly in the United Kingdom and the United States. Brian Wynne notes that '[d]espite the long career of these discourses, it is only since the mid-1980s that the PUS issue took on the trappings of institutionalization' (Wynne 1995: 361). Wynne (1995) offers a critical commentary on the emergence of this field. The journal *Public Understanding of Science*, which was launched in 1992, has been the main academic periodical of this sub-field. See also Gregory and Miller 1998.

23 Haraway, in effect, offers a 'diffraction' (my invocation of her own concept; see Haraway 1997: 14, 272–3) of Shapin and Schaffer's figure of the 'modest witness' through the story of Boyle and the experimental way of life (Haraway 1997: 33).

5 New reproductive technologies

1 As Pat Spallone (1992) and Karen Throsby (2004: ch. 8) argue, there are important connections between developments in these two fields.

2 The first version was given at Allegheny College, Meadville, Pennsylvania, in 1989 (McNeil 1993).

3 For a discussion of how feminist thought is created as well as communicated through rhetorical and other stylistic innovations, see Pearce 2004.

4 Childlessness has almost exclusively negative connotations. There is no noun equivalent to the somewhat more positive adjective, childfree. See Throsby's (2004) discussions of the linguistic constraints in this designation. See also Campbell 1999; Carter and Carter 1998; Ireland 1993; Woollett 1996.

5 In this respect I was influenced by the work of Sandra Harding (1986, 1991), Sharon Traweek (1988) and other feminists who have problematized the position of the neutral observer or analyst.

6 The history of in vitro fertilization (IVF), for example, can be traced back to experiments with mammalian eggs in Vienna in 1878, with the first successful extra-corporeal conception being reported in 1934. In the late 1940s human IVF was realized in the USA, but social pressure forced a halt to such experimentation in the 1950s (Lorber 1988: 119).

7 Objections have been raised about this term on grounds of it having religious connotations.

8 Throsby offers a similar proviso when she explains that she uses the term NRTs 'although this is not to suggest that they constitute a completely new departure or to disconnect them from their own histories' (Throsby 2004: 10).

9 Whereas Charis Thompson (2005: ch. 2) sees a clear break between a phase of feminist critical work on NRTs (from 1984 to 1991) and a later phase in which feminists were more positively oriented towards these technologies, I would highlight the importance of critical feminist perspectives across this entire period.

10 Another reason was the fear of the possible commercial exploitation of less well-off women who might be attracted to offer their services for financial reasons.

11 Amongst the many versions of this story are those offered by Donnison 1977; Ehrenreich and English 1979; Kitzinger 1967; Oakley 1976, 1984; Rich 1977; Stacey 1988: ch. 17.

12 This was the precursor to the UK Human Fertilisation and Embryology Authority (HFEA), which was established in 1990.

13 This redefinition of pregnancy can be linked to a long-term pattern of devaluing women's experientially based knowledge of pregnancy and childbirth. For a discussion of the elimination of 'quickening' as the marker of pregnancy in the Western world, see Duden 1993a: 79–98.

14 Thompson continues:

> The annual meeting of the ASRM [American Society for Reproductive Medicine] displays the extent to which drug companies and instrument makers collaborate with practitioners in research and in many other aspects of American assisted reproductive technologies. The development of recombinant fertility drugs, after an acute shortage of naturally derived ovulation-induction drugs in the mid-1990s, marked a new level of standardization of ovarian stimulation in IVF and illustrates well this aspect of ARTs.
>
> (C. Thompson 2005: 233)

15 Some early attempts to describe the commercial dimensions of NRTs were offered by Mies 1986 and, with particular reference to Australia, by Brown *et al.* 1990 and Koval 1990.

from: Maureen McNeil
Feminist Cultural Studies of Science and Technology,
London: Routledge, 2007.

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