My quartet of novels begins in 1953, the year of the coronation of the new Queen Elizabeth, and the year when Francis Crick and James Watson described the structure of DNA. In 1954 I went to Cambridge, which was later agitated by the ‘two cultures’ row between F. R. Leavis and C. P. Snow. Theodor Adorno, not only makes reference to Leavis and Snow but agrees that the idea of a university. As a young woman I felt that it was only possible to study literature and try to write if one had no such exclusive semi-religious attitude. But it wasn’t Snow’s polemic that interested me in science — partly because he didn’t say much about science, as opposed to its ‘culture’. I had had a very narrow (possibly also thorough) education. In my final years at school, languages and literature. No science at all. But I found that the writers I cared about most were in fact deeply interested in the scientific work of their time. George Eliot’s Middlemarch not only makes reference to Andreas Vesalius, to Bichat’s theory of primary tissues like webs, to optics: it weaves them into the structure of the story, the thought and the metaphorical form of the novel. In the same way Coleridge interested himself in optics, hydraulics, consciousness and growth patterns. I met John Beer, then doing his early work on Coleridge. He was interested in the way Coleridge’s coils and seashells in The Rime of the Ancient Mariner might relate to Coleridge’s interest in Goethe’s ideas about the spiralling forms of climbing plants. We stood on the pavement and he said to me that we were in the place where DNA had just been imaged for the first time. He made a tentative connection (metaphorical) between the DNA spiral and those earlier ones.

There was passionate discussion in literary departments at that time of T.S. Eliot’s theory of the “dissociation of sensibility”. Eliot believed that feeling and thought, body and mind, were a unified sensibility until the seventeenth century. After that you could no longer “feel your thought as immediately as the odour of a rose”. It is hard to recapture these odd beliefs now, but at the time I found them useful for the form of a novel about the body-mind problems of a young woman interested in her own sex-versus-intellect conflict, and also in the nature of metaphor; that is, interested in the brain’s excitement about making connections between disparate things.

I felt — and thought — that there should be people in the world of my novel who were interested neither in language nor in literature. One of these was the younger brother of my heroine Frederica. He is a character who is mathematically gifted and verbally inarticulate. He sees the outside world — and defends himself against its precipitous terrors — by mapping it geometrically as he moves in it. He sees and constructs the forms of his vision. I read a book about poetic metaphors in which the lovely story is told of the boy who always won at chess until he described how he instantly saw the best move — which was to visualize the chess board, and all the possible moves of all the pieces, in different coloured flashing lights, and choose the strongest pattern. After he had revealed his secret he collapsed in a faint. Somewhere at the same time I met the description of Francis Galton, who could visualize an imaginary slide rule and read off answers. I met a mathematical prodigy who — she said — solved problems by “imagining a garden and placing the mathematical forms in it.”

One reason all this fascinated me was that it was better than any literary description of what it felt like to seize the gestalt of a work of art — remembered, or half-constructed, or unwritten but present in the mind. I was aware of the ordering operations of my own neurons, in a shadowy way, and I tried to construct, with mnemonics, conscious patterns and colours and rhythms that represented this sense of form. I am not truly synaesthetic but I am haunted by the ghost of the possibility. And I became interested in the networks of connections that make the foundations for thinking — numbers, geometry and grammar. So my heroine, brooding about seventeenth-century metaphors in sensual language for what was beyond the sensual world, and my mathematician, were in fact struggling with the same problem.

The second novel in the quartet described in this article, A Whistling Woman, published by Vintage.

A. S. Byatt is a writer based in London. Her novel Possession won the Booker Prize in 1990. Her most recent book is the fourth in the quartet described in this article, A Whistling Woman,
meant to write it without metaphors and couldn't, which is how I discovered how fundamental metaphor is to thought. It is also a novel about perception — I was reading Richard Gregory and was obsessed with how we construct what we see, how we map what we see, what the brain does and what it cannot do. In Still Life I invented an imaginary university which set out bravely to be a real University. Like Keele University in its early days it was designed to make all-round 'Renaissance men' of its students. Keele had a compulsory first-year course where everyone learned languages and maths. That is long gone, as are the compulsory languages at Warwick University — the students demanded 'theory' instead. My metaphor for thinking is the combing of the neurons of the brain as a bird preens the hooks and eyes of a feather. I do not think 'theory' combs robust and useful neurons as maths and languages do. I invented a vice-chancellor — a Dutchman called Wijnobel — who is both mathematician and grammarian, like Noam Chomsky and Steven Pinker. He decides to hold a conference about the body and the mind, in which disciplines shall break their bounds, and artists and scientists shall talk and listen to each other. He is an idealist, and he is heading for the 1960s in which students believe in revolution and spontaneity, in New Age mysticism and not in scientific precision.

The third novel of the four is Babel Tower, and if Still Life was concerned with the life of the body, Babel Tower was designed to look at the life of the mind, especially the nature of language. I had been interested and somewhat perturbed in the 1960s by the growth of self-referring closed language-systems: sociology, psychoanalysis, hip and cool, and marxism, with their concomitant jargons. By the time I managed to write the novel, the closed languages had burgeoned into thorny thicket — semiotics, structuralism, deconstruction, lacanian psychology, feminist politics, and so on. They couldn't mostly be written into the novel; they came too late. But I had a moment of revelation when I realized that there was in fact a 'hard-wired' language that was universally human, and indeed extended beyond the human and united all the creatures of paradise or the planet. This was the four-letter code of DNA.

Thinking about this, I discovered a solid metaphor which I embodied in the language and the narrative of my novel. I realized, one idle morning, that a snail in Latin is helix. And a snail's shell is in the form of a spiral. Later I discovered that there were two species of snail, Helix hortensis and Helix pomatia (the snails of the garden and the grove), that could be fitted into both my paradise garden imagery and my realist scientific tale. By pure luck I met Steve Jones, an evolutionary biologist at University College London, on a science radio programme (we were actually talking about Marcel Proust and the concept of time in physics). I discovered that Steve was the world expert on what had (unfortunately for my verbal web) been renamed Cepaea hortensis and Cepaea pomatia. He had been studying the genetics of the external spiral of colours on the shells of the snails — work which the discovery of methods to extract DNA had rendered redundant. Novelists invent facts because of intellectual needs. I later asked Steve if he could see any connection at all between snails and work on neurons in the brain, on memory: he said that snails had giant neurons which made them peculiarly apt for this kind of experiment. I had an imagined woman scientist whom I needed to move from snail genetics to neuroscience. Curiosity is a profound drive in both novelists and scientists. I took great pleasure in learning about snails.

The other spiral that obsessed me was the Fibonacci spiral. It seemed to my non-mathematical brain a thing that could be made as a word game: take a number, add it to itself, the next number is the sum of the previous two, and so on. But this spiral informed (to use an old seventeenth-century word for shaping from within, like the soul in the body) all sorts of natural phenomena, from climbing plants to the sprouting of twigs round stems, from snails to pine cones and sunflowers. I discovered that Alan Turing had been obsessed by explaining this and had not had the computers to do it. I met John Maynard Smith at a Darwin seminar at the London School of Economics and Political Science and he sent me a paper by two French scientists in which they work out the maths and the mechanics of growth in biological Fibonacci spirals. I cannot really understand it, but I do try. I felt that the Fibonacci spiral was an example of a platonic order — a sense that an invisible mathematical order informed all our physical accidental world. My fearful mathematician at the end of the third novel moves from studying the computer as a brain to studying this spiral. This is for him a kind of parational completeness.

Writing Babel Tower meant going into all sorts of theories of learning and language. I was intuitively attracted to Chomsky's idea that language — a universal grammar — was 'hard-wired' in the brain. I remembered learning to read, I remembered learning French, and 'finding' rather than grimly docketing the shapes of the words and sentences. A book that has meant a great deal to me is Massimo Piattelli-Palmarini's edition of the debate in 1975 between Jean Piaget and Chomsky, at which all sorts of other thinkers from all sorts of disciplines were present, including Jean-Pierre Changeux who makes maps and metaphors of mental activity that move me as poems do. This
artists on science

"The quartet changed in the writing from a backward glance at the power of Shakespeare’s and Milton’s English and England, to a form excited by the mystery of scientific discovery."

he was the cauda pavonis, the peacock’s tail of multi-coloured light before the single white light of the opus, the philosopher’s stone. (Lysgaard is a common Danish name meaning garden of light, a paradisal reference.) I was able to make him discuss Darwin’s disgust at the idea of the useless peacock tail, which I had not known about when I named him. His research subject is also dramatically connected with his personal life.

The two visiting speakers, who hate each other, are Hodder Pinsky and Theo bald Eichenbaum. They are named, following the Norse mythological pattern of the novel, after Hodur, the blind god, and Balder, the ‘dying god’ whom Hodur kills accidentally with a mistletoe spear. In the scientific structure Pinsky was a cross between Pinker and Chomsky (although his work is more related to Ulrich Neisser’s Cognitive Psychology), and Eichenbaum is part of the ethologist world of Konrad Lorenz and Niko Tinbergen. Eichenbaum is suspect because he worked as a scientist in Nazi Germany and even published papers using Nazi language.

The paper that Pinsky gives is entitled “Metaphors for the matter of mind”. He explains that he is “interested in a science of mind that dealt with things that were only approximately objects of language at all”. He talks about the helpful, and simultaneously misleading, nature of the image of the atom as ‘order from noise’. And so on. I think it is a good encapsulation of something that was in the air.

Pinsky’s imaginary paper on the metaphors of our neuronal networks. I hope it is clear that love metaphor, as well as using it. It excites me. It is both helpful and unhelpful to think of the mind by using an image of a computer. Late in my writing I read Jean-Pierre Dupuy’s The Mechanization of the Mind — a 1994 study of the Macy conferences on cybernetics held between 1946 and 1953 on the relation between artificial intelligence, ‘information’ (a scientific concept that draws on the seventeenth-century neo-platonic idea of the forms that inform’ bodies and minds) and the brain. Cybernetics is itself a metaphor derived from the Greek for the tiller of a ship. Someone at those conferences — I think it was John von Neumann — was interested in why we enjoy puns, and suggested that it was because of the double, connecting/conflicting stimulation of a single synapse. I think that may be why we love metaphor, as well as using it. It excites our neuronal networks. I hope it is clear that Pinsky’s imaginary paper on the metaphors of mind touches on the recurring mysteries my novel looks at. (Maybe embodies.)
Eichenbaum's paper is never given, for the bacchic flood of demonstrators pulls him down from the podium. But I did invent his offending Nazified piece. It is a fictive essay called "Held und Herde" (Heroes and Herds) based on Galton's chapter in Inquiries into Human Faculty on "Gregarious and slavish instincts". Galton studied the behaviour of African cattle and distinguished between the adventurous and curious and the purely crowd-hugging ones. Galton calls the herds as an argument for eugenics — we need to breed more independent and responsible minds. I made my Eichenbaum an expert on herd behaviour, (shoaling, flocking) — and then described his 1940s paper on these scientific facts as written in language designed to appease the National Socialists' belief in eugenics and worthless slaves. He is pulled down, as I said, by a mob, and accuses them of being "the nastiest kind of herd — tame rats in a small enclosure".

At the end of Pinsky's paper, Frederica reflects that "though she had understood what he had said, which was lucid and interesting, she was profoundly ignorant, blackly, thickly ignorant, of what he was talking about. She knew the words, neuron, synapse, dendrite, and she liked them because she could do their etymology. But the human world — including maybe some of her own forebears — had invented microscopes and telescopes, had dissected tissues and identified cells, and if it all vanished tomorrow she would not know where to start, though she might be able to write down quite a lot of Paradise Lost by heart (whatever her heart was, and however it worked)".

The quartet changed in the writing from a backward glance at the power of Shakespeare's and Milton's English and England, to a form excited by the mystery of scientific discovery. My world has been changed by all the scientific writers who have made their understanding approximately available to me, in plain English and working metaphors. Sometimes I talk at sci-art gatherings at which Lewis Wolpert is present. He always argues that we non-scientists do not know what we are talking about. I do not dispute this — it is true, and it is important to know it. For my part, I wish scientists were less starry-eyed about what they call "originality" and — even more dubious — "creativity" in the arts. But that is another essay.

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**Science in literature**

**Simon Mawer crosses the divide to explore how scientists and novelists alike grapple with an uncertain world.**

When people discover that I have been, for much of my working life, a teacher, they evince little surprise. A teacher of literature, they assume. It's when I confess that I am a biology teacher that they are taken aback. A novelist who is a biologist is surely a contradiction in terms. Scientists are logic and facts; writers are imagination and fantasy; and between these opposite poles lies a profound gulf. Even today it is considered unusual for someone to cross the divide. Whether such an expectation originated with C. P. Snow's famous 1959 Rede lecture The Two Cultures and the Scientific Revolution I am not sure, but certainly his phrase has lodged in the collective mind almost as insistently as his other coining, the "corridors of power". Richard Dawkins would, one imagines, pronounce the "two cultures" a successful meme.

As a teenager with literary ambitions, but studying biology, this divide worried me. I couldn’t see why a scientist should not have recourse to wit and imagination, or a writer to careful logic and reason. The fact that Snow himself was a physicist gave me little comfort — his writing seemed exactly what one might expect from the science side of his own perceived gulf: all facts and little fantasy. But elsewhere there were stirrings of hope, flutterings of possibility. As an undergraduate I heard the Nobel laureate Niko Tinbergen start a lecture course on animal behaviour with the words, "Some people try to extrapolate from our studies to human behaviour but if you wish to learn about the behaviour of man don’t ask the ethologist; turn rather to the great writers. Read Dostoevsky, read Tolstoy." I paraphrase, but the sense is right.

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In the event it was another Russian who caught my imagination and my feeling for nature. I was studying entomology at the time, learning about the genetics of mimicry in Papilio dardanus, the African swallowtail, and somehow I came across this:

"The mysteries of mimicry had a special attraction for me. Its phenomena showed an artistic perfection usually associated with man-wrought things...When a certain moth resembles a certain wasp in shape and colour, it also walks and moves its antennae in a waspish, unmothlike manner. When a butterfly has to look like a leaf, not only are all the details of a leaf beautifully rendered but markings mimicking grub-bored holes are generously thrown in... I discovered in nature the nonutilitarian delights that I sought in art. Both were a form of magic, both were a game of intricate enchantment and deception".1