Ask why the weather is colder in the winter and you may well get the reply that, because its orbit is elliptical, the Earth is further from the Sun during winter than it is during summer and therefore receives less of the Sun's power at that time of year. This explanation fails to explain why the Southern Hemisphere experiences summer at the same time as the Northern Hemisphere experiences winter; that is, at the same stage of the Earth's orbit around the Sun. Talking through the logic of this example with students not only corrects the misconception, but also illustrates the scientific method by examining other necessary consequences of a given explanation before settling on the correct one. In this case, it is to do with the varying length of day and angle of the Sun in the sky.

Many of the examples presented by Comins are simple errors of fact. For example, "Polaris is the brightest star in the night sky", comes in at number 8 in the top 50 Cosmic Clangers (it is Sirius). Many others do not justify being called misconceptions at all. Time travel, which Comins takes to be self-evidently impossible, is not, as he claims, excluded by the general theory of relativity. On the other hand, he states that black holes are definitely not black because they give off Hawking radiation — this despite the fact that Hawking radiation has not yet been observed in an astronomical object.

And what is a misconception anyway? Contrary to popular belief, planetary orbits are not circular, and yet circles provide a useful approximate description for many purposes. We are told that they are actually elliptical, but this is itself an approximation that ignores perturbations from other bodies and relativistic effects. Most scientific explanations are misconceptions if you view them like this.

Much of the early part of *Heavenly Errors* is excellent, particularly its explanations of the basic astronomical properties of the Sun, planets and comets. But further on, the book goes badly off the rails. Through its conflation of fact and theory, and its blurring of the distinction between truth and approximation, it turns into a misguided crusade that encourages the rote learning of factoids as a means to "acquire a sound scientific foundation for understanding nature". I think this does more harm than good. T. H. Huxley, who knew a thing or two about science, put it best: "irrationally held truths may be more harmful than reasoned errors."

Peter Coles is at the School of Physics and Astronomy, University of Nottingham, University Park, Nottingham NG9 2HL, UK.

erratum In Edwin Taylor's review of *Mechanics of Motor Proteins and the Cytoskeleton* by Jonathon Howard (*Nature* **413**, 572; 2001), 'millimetre' in the third line of the fifth paragraph should have read 'micrometre'.

Science in culture

Reliquary and replication

A Genomic Portrait: Sir John Sulston by Marc Quinn.

Martin Kemp

We are all familiar with the stock portraits of scientists. They generally fall into three categories: evocative images of geniuses, in the Einstein manner; seated or standing subjects with suitable attributes, typically a piece of apparatus; and men and women "of action", posed as if working in the natural habitat of their labs.

Knowing what someone looks like may satisfy a basic human instinct, but it doesn't really tell us anything of importance about the scientist's significant intellectual and personal qualities.

A wholly alternative and headline-grabbing approach has been devised by the English artist Marc Quinn, who first came to fame for his sculpture of his own head cast in frozen blood. Commissioned to produce an image of Sir John Sulston, former director of Britain's Sanger Centre and international leader of the Human Genome Project, the artist and subject have collaborated to create something more like a religious reliquary than a standard likeness.

Sulston's own DNA was broken into random fragments and replicated in bacteria, which were cultured on a plate of agar jelly. The growth of the colonies was terminated at the point where they became visible as glassy beads scattered across the plate. The translucent, glistening 'picture', sharing its small scale with a snapshot rather than a grand painting, has been set within a broad silver frame, so shiny that the observer's own face is reflected in it.

But is it a 'portrait'? In that it contains certified fragments of the blueprint for a Sulston clone, it is in one sense a representation of him, or rather a re-presentation. It is as incontrovertibly individual as his fingerprints, containing those tiny quotients of genetic material that distinguish Sulston from Quinn, and all of us from primates. However, this level of individuality is not readily accessible to the spectator. It would need a Sulston and a Sanger Institute to undertake the analysis that would disclose the individualizing components. We simply can't tell, other than as an act of faith, that the beady traces embody Sulston's DNA rather than Quinn's.

I think it's not so much a functioning portrait as a kind of relic set in a precious vessel. In essence, it's akin to a bone fragment from Saint John the Baptist's finger, set in an incongruously elaborate masterpiece of the goldsmith's art — or, in a more secular context, the cherished curl of blond hair from a Victorian child preserved in a silver locket. There is that

Marc Quinn's 'portrait' of Sir John Sulston.

frisson of awareness that we are in the presence of something that is really part of the actual person rather than a mere optical record at one or more removes from the physical original. However, the traditional relic shares the problem of recognizability that bedevils Quinn's image.

The dusty fragment of ancient phalanx or fragile clipping of hair looks much like any old bone or curl of blond locks. Given the nature of Sulston's great achievement, the DNA reliquary could not be more appropriate, and it will clearly serve as an effective memento for visitors to the National Portrait Gallery in London. What it clearly does not do is serve as a wider exemplar for a new genre of individualizing portraiture. It is notable in this respect that the small exhibition staged to greet the portrait of Sulston contains coloured photographs of sitter and artist to tell us what they look like.

Martin Kemp is in the Department of the History of Art, University of Oxford, Oxford OX1 2BE, UK.

Sir John Sulston's 'portrait' will be on display at the National Portrait Gallery, London, until 10 February 2002.

Visualizations: *The Nature Book of Art and Science is a collection of essays edited by Martin Kemp (published by Oxford University Press and the University of California Press; £20, \$35).*

seventh sin) is different altogether. Persistence refers to the retention of highly emotional memories that one would rather forget. This independence of mechanism means that a treatment, such as a drug, developed to help 'memory' is unlikely to work on all of memory's imperfections.

Schacter's framework of research findings and interpretations, organized around his seven categories, succeeds in describing a discipline of work, theoretical and applied, that is both fascinating and of practical importance. The tip-of-the-tongue phenomenon (the feeling that a momentarily unavailable word or name is on the tip of the tongue) is experienced so similarly across cultures that 45 of 51 languages surveyed use expressions containing the word 'tongue' to describe this psychological state (including Estonian, Cheyenne and Afrikaans). What is commonly termed absent-mindedness (the second sin) is due to a disconnection between attention and memory, for example, a failure to attend at the moment when information is encoded. Absent-mindedness also occurs when retrieval cues are not available or are not noticed when an intended action is meant to be carried out.

Another imperfection involves the tendency to misremember the past so as to make it more consistent with current knowledge and beliefs (bias, the sixth sin). College students who were dating were asked about their partners on different occasions two months apart. Those whose evaluations become more negative during the two months recalled their original impressions as more negative than they actually were. Conversely, those whose evaluations became more positive recalled their original impressions as more positive than they actually were.

During the past decade, the fragility of memory became a prominent issue in the courtroom and in the news. Here, the guilty features of memory are misattribution (the fourth sin) and suggestibility (the fifth sin). Misattribution refers to errors in which a thought or a dream or a general feeling of familiarity is reported as a real memory. Suggestibility refers to distortions of memory through leading questions or other forms of influence. It is easy to demonstrate in the laboratory how readily individuals will succumb to memory errors of these kinds. After seeing a word list (bed, rest, awake, tired, dream, wake, snooze, blanket, doze, slumber, snore, nap, peace, yawn, drowsy), individuals frequently report with confidence that a highly associated word (sleep) was on the list. Persons with a capacity for vivid imaging, who score high on suggestibility scales, show a greater tendency for this effect.

There are many examples where misattribution and suggestibility appear to be at work. These include the corruptibility of young children's memories in the face of

leading questions, false confessions, early memories of abuse that were 'recovered' during psychotherapy (and later disavowed), and eyewitness misidentification. It is heartening to see that newer studies reviewed by Schacter are having practical consequences. For example, line-up identification procedures have been improved in some places by the simple expedient of presenting suspects one at a time and asking for a yes-no judgement. In the traditional method, the observer makes a choice after seeing all the suspects, but is vulnerable to error when the culprit is not in the line-up, because of a tendency to select the person who looks most like the culprit.

This book brings together an enormous amount of material in a form that is entertaining, informative and credible. It can both be enjoyed by the general reader and used as a resource by the specialist, as the text is accompanied by 19 pages of notes and citations supporting its empirical statements. Lawyers, judges, health-care professionals and others whose work sometimes relies on intensely practical questions about memory should also find it a welcome source of information. ■

Larry R. Squire is at the Veterans Affairs Healthcare System and in the Departments of Psychiatry, Neurosciences and Psychology, University of California, San Diego, California 92161, USA.

A physical view of the cytoskeleton

Mechanics of Motor Proteins and the Cytoskeleton

by Jonathon Howard
Sinauer/Palgrave: 2001. 384 pp.
\$59.95/£44.99

Edwin Taylor

The cytoskeleton consists of three kinds of fibrous protein filament — actin filaments, intermediate filaments and microtubules — plus the proteins that interact with them. The molecular motors myosin, kinesin and dynein run along the filament tracks. At least 100 other proteins interact with the cytoskeleton and new ones continue to be discovered.

The cytoskeleton is an area of intense research and we are in danger of drowning in a sea of facts. What should we try to teach our students about it? Popular textbooks devote one or two chapters to the cytoskeleton and motility and they can be supplemented by a book such as Dennis Bray's *Cell Movements* (Garland, 2001). But a textbook is needed which starts from first principles and leads to an understanding of the dynamics of the system.

And here is that book. In the first part, Joe Howard presents the physical principles that govern the behaviour of the cytoskeleton. It is a mechanical system composed of thin rods that are under stress. Movements occur in a medium in which inertia is negligible compared to viscous damping. The basic problem is the motion of a small elastic body in a viscous medium subject to an applied force and thermal motion. This problem is presented in a clear, conversational style and the level is that of a first-year college physics course in which some calculus is needed.

It may seem surprising that important properties of fibrous proteins and motors can be deduced from their resistance to stretching and bending, but proteins are large enough to be treated as bits of continuous matter. Howard points out that the elastic properties of these proteins have very little to do with the amino-acid sequence or even with the three-dimensional structure, because the proteins are held together by the same kinds of weak bonds.

Ask a student or colleague how long it takes a protein of relative molecular mass 100,000 to diffuse 1 millimetre, or what is the rotational time of a myosin crossbridge (or any other protein of similar shape). The chances are that the answers will be wrong by a few orders of magnitude. By including many simple calculations, some left for the reader to do, Howard succeeds in building up a feeling for the dynamics of the cytoskeleton.

The results derived in the first part of the book are then used to treat the mechanical properties of the cytoskeleton. The molecular motors myosin and kinesin are discussed in the third and final part. Howard is a major contributor to studies of kinesin, and provides a clear description of the techniques of mechanical measurements on single molecules.

This book would be an excellent text for a semester course on the cytoskeleton and motility. Most of the topics are accessible to students who have had a course in physics. Some topics in diffusion and thermal motion use more advanced mathematics, but the solutions to equations have been wisely placed in an appendix where they don't get in the way of the reader who is interested in results, not mathematical derivations. It will also be a valuable reference book for researchers in the motility field.

Students on general cell-biology courses often have an aversion to equations, but a selection of some of the results discussed in this book would be a valuable supplement to such a course. ■

Edwin Taylor is in the Department of Molecular Genetics and Cell Biology, University of Chicago, 920 East 58th Street, Chicago, Illinois 60637, USA.