avoids the pitfalls of simple, unicausal explanations. She sensibly employs current biomedical knowledge while cautioning of the dangers of applying models built on current third world experience to the evidence from nineteenth-century Britain. Best of all, this book raises many new questions that will influence how the rest of us do our research in the future.

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LEO HOWE and ALAN WAIN (eds), *Predicting the future*, Cambridge University Press, 1993, pp. vi, 195, illus., £18.95, $29.95 (0–521–41323–0).

Predicting the future is a risky business and few of the authors are prepared to try it. Rather they analyse the past and present. Stephen Hawking does however consider the future of the universe. He would have liked at one stage to write a history of the future about how most predictions turn out to be very wide of the mark. Here he suggests that the behaviour of the universe on a very large scale seems to be rather simple and so one can predict whether it will expand forever or eventually recollapse. He hedges his bets by predicting both ways.

Unlike the large scale behaviour of the universe, tiny changes in the initial conditions of dynamical systems, even like a free-swinging pendulum, can make its behaviour chaotic and hence unpredictable in detail. Ian Stewart looks at how one can analyse the equations that govern such systems and how considerations of symmetry can make sense of the patterns of fluid flow which can suddenly break up into layered vortices. Symmetry and chaos, pattern and disorder, coexist within the same mathematical framework.

Simon Schaffer examines prophecy as a question of trust with an historical analysis of attitudes towards comets. He argues that the culture of the wider public has an affect on the specialist predictions. He sees the common talk of impending disasters like British economic collapse as being sustained by the image of cometary prediction.

Understanding is not the same as predicting as Frank Hahn discusses in relation to economics. One cannot expect predictions from social science but that does not mean there is no understanding. Geologists can understand earthquakes but cannot predict them. Understanding should be seen as placing restrictions on what the world can be like.

Ian Kennedy sees bioethics playing an increasingly important role in medicine. For example, as developments in human genetics advance they may bring with them a "tyranny of knowledge", which forces choices upon people for which they are not yet prepared. There is also the hard question of allocation of resources and the balancing of people's rights and duties.

The last three essays deal with religious aspects of the past and future. Problems arise from God's omniscience and plan for the world, the co-existence of good and evil, and our supposed free will. Averil Cameron examines the efforts made by the church in late antiquity to win adherence to the Christian scheme of providence in the face of both secular and non-secular explanations. In Buddhism, as Richard Gombrich points out, the emphasis is on the individual. It also draws no sharp line between humans and animals, and reincarnation can be into one of many life forms. To attain nirvana is to get rid of all desire and delusion. The future is determined but irrelevant. Finally, the idea of the Last Judgment is discussed by Don Cupitt. The idea that we must, after our death, face a moral tribunal before which we must give an account of our deeds, is found in almost every culture and is first recorded in Egypt some 2500 years ago. But the story that at the end of time everything will make sense does not itself make sense until the end of time. We will never know where it is all going and so our anxieties about the future will persist, forever.

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HANS-JÖRG RHEINBERGER and MICHAEL HAGNER (eds), *Die Experimentalisierung des Lebens: Experimentalsysteme in den biologischen Wissenschaften, 1850/1950*, Berlin, Akademie Verlag, 1993, pp. 248, illus., DM 78.00 (3–05–002307–4).

Following the historiographical programme instigated by Bruno Latour and Steve Woolgar to study "Laboratory life" and "Science in action", this volume deals with experimentation in the life sciences in the period between the emancipation of experimental physiology from anatomy (around

1850) and the establishment of molecular biology (in the middle of the twentieth century). Its thirteen essays, which originate from an international symposium held in Lübeck in 1991, are partly case studies into key issues of this programme, partly reflections on its consequences for the history and philosophy of science.

Concentrating on the process of experimentation (rather than on scientific theories), several contributors investigate the implications and dynamics of so-called experimental systems. One main topic is "inscriptions" and "material representations" of physiological and biological phenomena: Soraya de Chadarevian looks into the great range of self-recording instruments in the tradition of Carl Ludwig's kymograph; Timothy Lenoir studies Hermann von Helmholtz's models for the perception of tones and colours, which—as he shows—were informed by the new media technologies, especially the telegraph; and Hans-Jörg Rheinberger, in a short history of the microsomes, traces the shifts in their representation through histochemistry, centrifugation, and electron microscopy, as well as the fluctuation of their context between cancer research (tumor agents) and cytomorphology. The aspect of feasibility in experimental research and the interrelation between laboratory and clinical work are highlighted in other contributions: Michael Hagner argues that it was Eduard Hitzig's experience in electrotherapy, combined with Gustav Frisch's anatomical expertise, that led to their famous experiments on the electrical excitability of the brain, and that it was rather the dynamics and clinical relevance of their experimental system than the quarrel between localizationists and holists that caused the rise of work on cerebral localization in the last third of the nineteenth century. Heinz-Peter Schmiedebach characterizes different "strategies" of experimentation in different contexts: while Rudolf Virchow used his morphologically orientated experiments on arteritis in establishing his cellular pathology, Ludwig Traube tried to support his diagnostic methods (percussion and auscultation) with step by step experimentation on the mechanisms leading to lung diseases, using systems that were similar to those of physiologists. And Nelly Oudshoorn suggests that the development of biological tests for sexual hormones in the 1920s resulted in a new, more quantitative than qualitative classification of gender and sexuality, as well as in therapeutic intervention in homosexuality.

The factors determining the acceptance of scientific work are the focus of two other papers. Applying the metaphor of contemporary "resonance", Bettina Wahrig-Schmidt and Friedhelm Hildebrandt examine the question why Nikolaus Friedreich's suggestion of 1867 to use the occurrence of deformed erythrocytes in the urine as a diagnostic criterion to distinguish renal from extra-renal haematuria sank into oblivion (to be taken up again by nephrologists only in the 1980s). Looking into a story of success, Ilana Löwy argues that Macfarlane Burnet's rather undefined concept of the "immunological self" constituted a "boundary object", which allowed the co-operation of various groups of scientists and clinicians and thus became instrumental for the rise of immunology as a discipline in the 1960s and 1970s. Some contributors, e.g. Robert Olby in a paper on Mendelian genetics in Britain, and the commentators Christoph Meinel and Bernhard Siegert, try to redress the balance by cautioning against an over-emphasis on experimental systems at the expense of social and intellectual history. Peter McLaughlin finally reflects on the philosophical consequences of experimentalism, concluding that, from a rationalistic point of view, the claim to find "truth" through experimental science has to be given up.

One important question arising from the papers of this volume, also addressed in the editors' helpful introduction, is whether it is justified to speak of "experimental strategies" (as Schmiedebach does), or whether one can see only "blind tactics" and a "groping" character of experimental work (like Rheinberger). Meinel suggests in his thoughtful commentary that the preference for one or the other interpretation may depend on the greater or lesser distance of the historian's chosen perspective and on the type and rhetoric of the examined sources. The strength of all the papers lies in the elucidation of theoretical (and historiographical) questions such as this, rather than in enabling us to abstract a succinct story of experimentation in the life sciences from 1850 to 1950. Therefore this book should not be missed by anyone with an interest in understanding the "making" of science, be it in history or today.

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