

the fine structure of eosinophils and basophils.

In a work of this magnitude, there are bound to be points to quibble with. Most of the illustrations are superb, but on p.160 two myeloblasts are compared at different magnifications, and one of them is out of focus (no wonder the other appears more mature!). Some of the pictures of malaria parasites are also sub-standard. As for omissions, it is a pity not to find an illustrated discussion of the erythrocyte cytoskeleton in a book that is otherwise an excellent introduction to cell biology. Also, an atlas is made of maps, and although those of the immunoglobulin genes are generously portrayed, one misses those of thalassaemia mutations and of the chromosomal localization of genes expressed in blood, other than oncogenes.

For the past 20 years, experimental haematology has been largely identified with culturing haemopoietic cells. Much work has been frustrated by the extreme difficulty in isolating and obtaining the required growth factors, but with the cloning of the respective genes it is now possible, for instance, to grow erythroid cell colonies in a fully synthetic medium containing erythropoietin produced in an expression vector. The first chapter of the *Atlas* provides a good introduction to perceiving how these culture systems will help the understanding of the cellular and humoral control of haemopoiesis. The *in vivo* counterpart of this approach, at the clinical end of the spectrum, is illustrated in the last chapter; the senior author, Dan Thomas, is the justly acclaimed pioneer of bone marrow transplantation (BMT), the single most significant advance in haematological therapy. Reconstitution of haemopoiesis after BMT is also a dramatic *in vivo* experiment in developmental biology, which may tell us something about the elusive stem cells and perhaps give us a way to isolate them. These are the cells that will need to be handled if gene therapy experiments aiming to correct blood disorders are to succeed.

For the practising haematologist the *Atlas* will be a well-deserved luxury; for the scientist who wants to know about the potential of blood cells to investigate cell biology it is a perfect complement to *The Molecular Basis of Blood Diseases* edited by Stamatoyannopoulos *et al.* (reviewed in *Nature* 329, 210; 1987); for every laboratory of diagnostic or research haematology it is a must. But I hope the next edition will include a picture at atomic resolution of how erythropoietin fits the erythropoietin receptor: that will be molecular morphology at its best. □

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Mental manoeuvres

Donald Broadbent

The Making of Cognitive Science: Essays in Honor of George A. Miller. Edited by William Hirst. Cambridge University Press: 1988. Pp. 284. £25, \$29.95.

GEORGE Miller belongs to the small minority of key figures who have altered the shape of a subject. By origin a psychologist, he seized on the possible connections between that discipline, mathematics, linguistics and engineering, and showed that it was possible to discuss 'mental' events in precise and scientific terms. If it is now sensible to speak of a single area of 'cognitive science', as an offspring of the original disciplines, George Miller has a good claim to pater-



From *The Making of Cognitive Science*

George Miller — startling ability.

nity. Unusually for a *Festschrift*, the tributes to him and the acknowledgements of his work to be found in the book are not exaggerations but are sober truth.

In plan, the book follows his career and samples his main areas of research. The first section contains chapters about his early work in the Harvard Psychoacoustic Laboratory, each discussing a technical area clearly and intelligibly enough for the non-specialist to realize why Miller is of such standing. The second section deals with the later founding of the Center for Cognitive Studies, still at Harvard, and reports the experience of people there rather than considering the problems they worked on. The impact of the Center was to create a group dedicated to examining 'mental' events, with implications far outside Miller's immediate areas of interest. As just one example, it was the first university laboratory to use a computer to control psychological experiments.

These two sections are probably the strongest in the book. Generations of students know Miller through his elementary text, a warm and humane volume, centred on personal interactions and contributions, and it may be salutary for them to be reminded of his hard mathematical and experimental base. It was his emphasis on rigorous and precise formalization, and not simply his broader human sympathies,

that made him able to appreciate the importance for other disciplines of Noam Chomsky's mathematicization of grammar. He thus launched a whole generation of psychologists on experimental studies, largely aimed at establishing whether human use of language could be modelled by Chomsky's formulation. That enterprise is described in two of the contributions in the third section. The book makes it clear that the enterprise failed, in the sense that this form of grammar is a poor theory of human performance at processing sentences. Yet experiment and theory about such processing, with the numerous complex internal operations it requires, were shown to be possible. They will never now disappear from psychology.

Part of the reason for the inadequacy of early syntactic theory to produce a theory of human language use lies in the pervasive role of our knowledge about the world. In Quillian's example, that knowledge is revealed by the assignment of different syntactic structures to the sentences "He had some dirt from his farm by the Hudson river" and "He had some dirt from his farm by his foot". That is why, on moving from Harvard to Rockefeller in 1968, Miller increasingly turned to semantics and continued to do so at Princeton after 1979. The fourth section contains chapters that give suggestive examples of topics that can be studied in this area, and a hope for the future in the procedural approach urged by Johnson-Laird. This research area, however, is not as advanced as the earlier ones described in the book, and that is even more true of the attempts to link brain damage and function in the fifth section. The two chapters concerned return to accounts of personal experiences of Miller's startling ability to stimulate those around him, as demonstrated in his Rockefeller years; but the examples of neurological cases are largely from other laboratories. Finally, the sixth section examines the current status of cognitive science, through the eyes of a philosophical colleague at Princeton.

Hardly anybody will find all of the contributions suitable reading. For the enquiring outsider, some parts make a good introduction to the value of Miller's work. The general reader will find others too specialized and without a close connection to Miller's own thought, even though they report excellent technical work. For those who have known him, other parts again will be pleasant reminders of his lively and engaging personality. But the best monument to Miller is not simply this volume; like Wren's, it lies in everything we see around us in the study of cognition. □

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