one flagellar protein to another, a gene is apparently coupled and uncoupled from its regulatory site by reversible recombination.

It is clear from these last two examples that gene expression is regulated by a variety of mechanisms. It seems likely to me that there are mechanisms not yet conceived that are at work in nature. To those who claim that we know all about how gene expression is regulated in bacteria, I would point out that only a dozen cases have been analyzed in sufficient depth to reveal the basis of their regulatory mechanisms. Nearly all these cases are in enteric bacteria. What mechanisms are used, for example, to control genes for nucleotide biosynthesis or fatty acid metabolism in *E. coli* or to control genes in other bacteria? Each case studied so far has provided new insights, and unimagined mechanisms surely await discovery. The analyses described in *The Operon* provide an excellent guide for further biochemical and genetic studies of gene expression, both in prokaryotes and in eukaryotes. Particularly valuable are the chapters by Beckwith and his colleagues discussing the genetic analysis of operons with transpositions, deletions, and gene fusions.

Two aspects of the subject are not dealt with in the book. First, many well-studied operons are mentioned only in passing, if at all. The volume would be a much better source book if other operons, such as *mal*, *bio*, *ilv*, *glp*, *thr*, *his*, *arg*, *deo*, *bgl*, and *rha*, had been at least briefly described. Second, the book lacks a discussion of the common theme of operons and variations on it, such as I have briefly attempted in this review. The reader achieves an overall view of strategies of regulation only by making his or her own synthesis. It is particularly unfortunate that some excellent reviews of operon control are not cited in the book. For example, a review on autogenous regulation by Goldberger (*Science* **183**, 810 [1974]) should have been mentioned in connection with λ and *hut*, whose repressors are self-regulating. A consideration of several operon regulatory strategies by Savageau (*Biochemical Systems Analysis*, Addison-Wesley, 1976) is also not mentioned. Editors of collections of this type should provide overviews to aid readers unfamiliar with the field, readers for whom these collections are particularly valuable.

How widespread are operons? They have been described only in bacteria and their viruses. Clusters of related genes controlled by an adjacent site have not, to my knowledge, been unequivocally demonstrated in eukaryotes. Yet the basic element of the operon, a gene with an adjacent controlling site, appears to be universal. Of the several mechanisms of regulation described for bacteria, which most closely resembles that utilized by eukaryotes? There are indications, for example from immunoglobulin synthesis and from yeast mating-type interconversion, that the recombination mechanism operating in flagellar phase variation may be one strategy adopted by eukaryotes. Whether repressors and activators are present in eukaryotes should be known in the near future.

This volume, like the concept of the operon, should be a valuable aid to investigators of gene expression both in prokaryotes and in eukaryotes in that it demonstrates the power of coupling genetic and biochemical approaches to solving basic biological problems.

GERALD R. SMITH
Institute of Molecular Biology, University of Oregon, Eugene 97403

Theories of Memory

Perspectives on Memory Research. Essays in Honor of Uppsala University's 500th Anniversary. Papers from a conference, Uppsala, June 1977. LARS-GÖRAN NILSSON, Ed. Erlbaum, Hillsdale, N.J., 1979 (distributor, Halsted [Wiley], New York). xiv, 400 pp., illus. $24.95.

This volume comprises 16 papers on the psychology of memory that were presented at a conference held in commemoration of Uppsala University's 500th anniversary. Although one or two of the contributors make occasional reference to "the past 500 years," the birth of Uppsala University did not coincide with any major development in the psychology of memory. If there were to be any commemorative dates, after one marking the publication about 100 years ago of the first major experimental study of memory, there would be one marking a fundamental shift that occurred about 20 years ago from a pretheoretical orientation based on a simple associationism to an orientation incorporating more complex, information-processing concepts. Thus, whereas in the 1950's the rememberer was seen as a passive associator of stimuli and responses, in the 1960's he or she became a more complicated processor of information. The radical nature of this conceptual reorientation is illustrated by comparing the subject index of the present book with that of the leading textbook of the 1950's, McGeoch and Irion's *The Psychology of Human Learning*: the books share fewer than 2 percent of even their first-level entries.

In both the preface and his introductory chapter, Nilsson ponders the new levels of complexity that these last 20 years have brought and argues that the field has become "far too diverging . . . leading everywhere and possibly nowhere" and that there "seems to be a strong need for some overall perspective." He sees the main purpose of this volume as providing a start toward meeting this need.

Measured against this criterion, it is unlikely that the book will achieve any perceptible success. In most cases the contributors have written with a broader sweep than they usually do, but they have nonetheless fallen a long way short of clarifying the relations among their theories. Nilsson's valiant attempts to identify global theoretical perspectives add up to no more than one person's grouping of an extraordinarily diverse set of chapters.

The metatheory of humans as information processors has given rise to a proliferation of new procedures and findings that have called for more complex theories, which in turn have resulted in more procedures and findings. This spiraling complexity is illustrated in the present volume in four chapters (by George Mandler, Fergus Craik and Larry Jacoby, Donald Norman, and Gunnar Johansson) in which the authors update their earlier theorizing, as well as in a chapter by Alan Allport on production systems and in one by Bennet Murdock describing a new model based on principles of correlation and convolution. Although some people see this tendency for researchers to develop their own, personal theories as a sign of health, others, like Nilsson, are troubled and want theorizing constrained in some way.

It is one thing to argue that theorizing needs pruning to sustain vigorous growth but quite another to know how the pruning should be done. Some understanding of the problem can be gained from, conveniently enough, a consideration of the remaining chapters.

Of most direct relevance is a provocative and entertaining chapter by Endel Tulving. Although not entirely pessimistic—he raises the possibility that research endeavors may be just now reaching critical mass—Tulving questions whether the vast amount of research done over the last 20 years adds up to much real progress. He offers a set of

guidelines for future research that all those in the field could profitably consider.

Each of the various approaches to understanding memory taken by the other contributors offers a way in which mode of theorizing might be anchored and constrained. First there is a conceptual or philosophical approach, represented by a chapter by William Estes distinguishing among functions of a theory and by a wild and wonderful chapter by Michael Turvey and Robert Shaw advocating a new metaphysics. But as a science the study of memory needs more concrete moorings than can be gained from purely philosophical considerations. A second possibility, a physiological approach, is no more helpful. As is illustrated in chapters by Holger Hydén on protein synthesis in the brain and David Ingvar on cerebral blood flow, the content of this approach is currently far too remote from the phenomenological and behavioral manifestations of memory to be relevant to the concerns of most psychologists.

The remaining two approaches might suit the purposes better. One is concerned with the pathology of memory and the other with the analysis of problems in the world outside the laboratory. The former is represented by rather similar chapters by Tim Shallice and the late Alexander Luria, the latter by a chapter on reading comprehension and readability by Walter Kintsch and Douglas Vipond and by one on face recognition by Alan Baddeley. These approaches not only are concrete but may also be of sufficient psychological relevance to constrain theoretical development in a satisfactory way. Thus, theories of memory could be evaluated according to whether they allow an adequate account of known malfunction or by a criterion of relevance to matters of everyday life. But, for the time being at least, most theorists, including most of the contributors to the present volume, apparently see no need for such evaluation.

There is little doubt that the book will be seen as an important contribution to the field, for indeed it is a collection of major statements from many of today's leading memory researchers. And yet, even though its chapters are theoretical and speculative, the overriding impression the reader is left with is that the field is diverging at an unprecedented rate and that the prospects of theoretical unification have never been more remote.

MICHAEL J. WATKINS
Department of Psychology,
Princeton University,
Princeton, New Jersey 08544

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