Church did condemn Copernicanism in 1616, and it did warn Galileo to abandon his campaign in favor of the new astronomy. In 1638 the Papacy would allow Castelli to visit Galileo only if a third person were present to insure that they would not conspire together about Copernicanism. Avoiding anachronism and sensitivity to the civilization of the 17th century require one to acknowledge these facts also.

I have stated my disagreement with nearly all of Redondi's theses. Nevertheless, I welcome his book. For one thing, it is written with an acute appreciation of dramatic incidents, so that it is a pleasure to read, even for one who finds himself dissenting. More important, the book has forced me carefully to reexamine fundamental issues connected with Galileo's trial and to consider the bases on which my own understanding of that momentous event rests. In the brief space that a review allows, I have attempted to state the grounds of my disagreement. I am well aware, however, that I have not been licensed to speak final truth on the matter. Informed discussion is the essence of the enterprise, and one cannot appreciate too highly a book that promotes informed discussion, even when, as in my case, one ends up rejecting its position.

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Mathematical Psychology

Response Times. Their Role in Inferring Elementary Mental Organization. R. DUNCAN LUCE. Clarendon (Oxford University Press), New York, 1986. xvi, 562 pp., illus. $75. Oxford Psychology Series, 8.

Hoping to learn critical aspects of the mechanisms underlying behavioral response, researchers have been measuring response times since roughly the middle of the 19th century. The lack of a convenient and accurate apparatus has not deterred them. For instance, Carrard, around 1890, used to have his subject put his hand around a fixed graduated cane, without touching it. Simultaneously with the presentation of a signal, the cane was released. The subject was instructed to react to the signal as quickly as possible by closing his hand on the cane. A reading of the graduation on the cane at the level of the hand provided a means of measuring the latency of the response.

In his well-documented book, R. Duncan Luce, a mathematical psychologist, cites more than 630 references, about 80 percent of which deal specifically with response times, either theoretically or experimentally. The standard argument in favor of measuring response times is that their analysis may reveal the organization of the mental phenomena underlying the observed response. This strategy, however, invites skepticism. In Luce's words (p. 1): "Consider the task of inferring the architecture of a computer from measurements of its performance times using different programs and different inputs. This certainly would be difficult, especially if one lacked the technology of modern electronics to help carry out the measurements. At best, one would expect to learn something about the gross organization of the computer, but it seems unlikely that the fine details would succumb to such an attack."

A widely accepted concept, originating with the physiologist Donders (1868), is that the observed response time results from the addition of a potentially large number of component times: the signal energy must be transduced into neural spike trains, a reaction of the sensory receptor must be evoked, the reaction must then be transmitted to a central decision center, and so on, up to the motor response. Luce follows that reasoning but groups these components into two classes: the decision time and the residual time. The book focuses on the decision time and is largely concerned with modeling the cognitive aspects of the task presented to the subject in an experiment.

In view of the large variability of response times (a standard deviation of as high as 100 milliseconds for a mean between 200 and 600 milliseconds is not rare), most reaction-time models are probabilistic, and the standard stochastic library has been sampled with abandon. An extensive and well-presented account of this work can be found in this book, which will certainly remain the basic reference for years to come. A few examples will give a flavor of the diversity of the models and techniques in use in this field.

Some theoreticians have been concerned with predicting the exact shape of the reaction-time distribution. One assumption, reasonably successful in some simple situations (from the viewpoint of statistical goodness-of-fit), is that the reaction time is the sum of two independent random variables, one Gaussian in distribution, the other exponential. In the same vein, others postulate that the reaction-time distribution can be described by a so-called generalized gamma random variable, that is, a sum of independent exponential random variables with possibly different time constants. Much more ambitious are constructions that attempt to model explicitly the unobservable mechanisms of the decision. For instance, the observed reaction time has been regarded as resulting from a counting process, as if the brain were keeping track of the number of spikes occurring in some neural location. It has also been modeled as a random walk, inspired by Wald's sequential analysis.

Founding the working details of a model on unobservable events in the organism is an exciting but risky enterprise. However appealing, a model is rarely unique: models based on drastically different principles may give undistinguishable predictions. Some researchers have directed their efforts towards the theoretical description of very complicated situations, such as choice reaction time, memory scanning, and search paradigms; in such situations, a single model that yields a detailed, economical description of a complex set of data may turn out to be useful, whether or not its basic principles are ultimately correct. Again, standard stochastic concepts, such as Markov processes (finite and continuous), have provided the basis for the models. In some cases, the assumptions of a model are such that, at least for the time being, only a deterministic version can be worked out. For example, Schweikert uses a method called "critical path analysis," borrowed from operations research and computer programming, to infer a processing network from overall response times. As in the rest of the book, Luce's description of this work is both precise and highly readable.

In general, Luce's viewpoint and writing style are those of a theoretician. Data are nevertheless treated with respect and discussed in minute detail. The book will be useful to many, whether or not they are theoretically inclined, and will be mandatory reading for anyone dealing with behavioral response times.

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Transforming Genes

Oncogenes, Genes, and Growth Factors. GORDON GUROFF, Ed. Wiley-Interscience, New York, 1987. xiv, 386 pp., illus. $69.95.

Oncogenes and Growth Control. PATRICIA KAHN and THOMAS GRAF, Eds. Springer-Verlag, New York, 1986. xxiv, 369 pp., illus. $69.50.

The confluence of research in the regulation of cell growth and in the study of transforming genes has been one of the major accomplishments of the last decade.

Cell biology and biochemistry have outlined the general framework for growth regulation, and the study of transforming viruses has provided the molecular biology and many of the genes that play critical roles in growth regulation. To date transforming genes have been found to be related to growth factors, growth factor receptors, presumed signal transducers in growth factor regulation, and transcriptional regulators of genes implicated in growth. These two books, though similar in scope, deal with the relationships between growth factors and oncogenes in contrasting and complementary ways. One book treats several specific topics in depth, whereas the other is global and summational in approach.

In *Oncogenes, Genes, and Growth Factors* the emphasis is more on growth factors than on oncogenes. The book contains 12 balanced and detailed reviews that cover several of the known growth factors. There are excellent chapters on platelet-derived growth factor (PDGF), epidermal growth factor (EGF), nerve growth factor (NGF), transforming growth factors (TGFs), interleukin-3 (IL-3) and granulocyte-macrophage colony-stimulating factor (GM-CSF), erythropoietin, interleukin-2 (IL-2), and transferrin. The chapters describe the development of knowledge about growth factors and provide details of their structures from biochemical studies and from gene cloning.

In addition, there are chapters on the growth-factor receptor genes for EGF, IL-2, and transferrin. The chapters dealing with the EGF receptor and transferrin receptor genes provide an introduction to the isolation, characterization, and cloning of the genes as well as the relationship of the EGF receptor to the *erb*B transforming gene. With regard to the chapter on the IL-2 receptor, the authors appropriately note that only half or less of the story is in and that understanding the structure of this receptor will require the identification and purification of a second chain. Nevertheless, the authors have reviewed the early studies and current research on the beta chain of the receptor, which is detected by the anti-TAC monoclonal antibody.

Perhaps appropriately, the last chapter is about the interactions of peptide growth factors and oncogenes. The authors initially review the cell biology relating to the concepts of competence and progression. Next they discuss the role of growth factors in competence and progression, and finally they consider the relationship of oncogenes such as *myc* and *fos* to growth factor inducible genes. The rate at which new information is being generated in this area is attested to by the presence of five sections as an addendum to the chapter. Nevertheless, the chapter is useful for its treatment of the development of many of the concepts that are being currently pursued.

The editors of *Oncogenes and Growth Control* set out to "produce a collection of mini-reviews which present an overview of the current concepts without a lengthy description of the primary data." This goal has been admirably fulfilled. The 47 papers in the book are arranged in six sections. The editors have written a short introduction to each section that helps the reader to appreciate and integrate the sometimes diverse subjects covered. They have also included a summary table of the oncogenes discussed in the book to assist those not yet acquainted with the three-letter code that pervades the field.

The sections in the book vary considerably in size and emphasis. The first section deals with growth factors and proto-oncogenes in development and differentiation. The three reviews in this section collectively provide a brief but detailed survey of the role of proto-oncogenes in development. The second section treats growth factors, receptors, and related oncogenes and contains 14 reviews. Within this section several growth factors (hematopoietic growth factors, PDGF, TGFs, EGF) and growth factor receptors (EGFr, CSF-1r, IL-2r) are reviewed irrespective of whether they were ever transduced into a transforming virus. In addition, reviews on *abl*, *mos*, and *src* are included. The third section deals with the role of proto-oncogenes in signal transduction mechanisms and contains nine mini-reviews. The editors have included in this section reviews covering protein kinase C, the phosphatidylinositols, and G proteins in addition to the more familiar oncogene topics *ras* and tyrosine phosphorylation. The fourth section deals with the nuclear oncogenes and the regulation of gene expression. Here the editors have included chapters on biological systems such as the regulation of globin gene expression and the regulation of gene expression by steroid hormones that, although they do not directly involve oncogenes, provide a framework in which to view the possible role of proto-oncogenes.

The fifth section deals with the idea that fully malignant transformation often, if not always, involves multiple individual transforming events that affect different cellular functions. Chapters examining this in the malignant transformation of fibroblasts, hematopoietic cells, epidermal cells, B cells, and in tumor progression give details of the hypotheses and mechanisms currently under investigation. The final section, consisting of one chapter, considers oncogenesis in transgenic mice.

In summary, both books are of considerable value as reference sources. *Oncogenes, Genes, and Growth Factors* is particularly useful because of the detailed information it provides on a number of the well-characterized growth factors. In contrast, *Oncogenes and Growth Control* is valuable because it furnishes an overview of the expansive area of oncogene research and its integration with research on the regulation of growth and differentiation. The "mini-review" format with its emphasis on summary tables that give a lot of information in a relatively small space is a nice change from the more conventional form of review.

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