and attempts to determine the type of knowledge characteristic of each field. Readers who have struggled to understand the distinctions in knowledge, as they are presented by Kant in his *Critique of Pure Reason*, will find Barker's explanations much clearer than the original. One may question whether the type of knowledge characteristic of the various fields of mathematics is the central problem today in the philosophy of mathematics. One may also wonder at the preeminence given to Kant to the neglect of other outstanding philosophers who developed theories of knowledge. The restrictions are no doubt intentional and reflect Barker's convictions.

The second and third chapters deal with Euclidean and non-Euclidean geometry. The nature and role of the postulates, definitions, axioms, and theorems of Euclidean geometry are discussed against the background of the types of knowledge presented in the first chapter. Since many aspects of Euclidean geometry are quite familiar to the general reader, this chapter, with its many concrete and apt illustrations, provides interesting reading. On the other hand, non-Euclidean geometry is somewhat sketchily presented and requires professional competence with the subject in order to appreciate the author's analysis.

Cardinal numbers (finite and transfinite) and real numbers are discussed in the fourth chapter. One expects and finds here the viewpoints of Peano, Cantor, Frege, Russell, and Whitehead. An attempt is made to classify the thinking of these mathematicians (and that of a few others) in the standard philosophical categories: for example, nominalism, conceptualism, intuitionism, and realism. The exposition of cardinal numbers and the statement of the difficulties inherent in the concept of the transfinite are both excellent. The philosophical tenets of the nominalists, conceptualists, and others are stated briefly and clearly, but the analysis of these attitudes is reserved for the next chapter.

The final chapter deals with the paradoxes of set theory, the consistency and completability of deductive systems, and the currently prominent mathematical philosophies: formalism, logicism, and intuitionism. The author's incisive analysis of each of the three major philosophies ends in a genial compromise: the house of mathematics has many mansions, and in it many games are played. Of the latter fact, most mathematicians have a priori, empirical, analytic, and synthetic knowledge.

The editors hope that the material in the book will be used to supplement lectures in undergraduate philosophy courses. Experience indicates that there are not too many mathematicians who are philosophers and fewer philosophers who are mathematicians. Moreover, philosophy (even philosophy of mathematics) is presently ignored by young men who regard it as an old man's preoccupation. This book may well be one small step in making philosophy of mathematics a young man's interest, if not his vocation.

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Pharmacology

Molecular Pharmacology. The mode of action of biologically active compounds. vol. 1. E. J. Ariëns, Ed. Academic Press, New York, 1964. xxii + 503 pp. Illus. $17.

Volume 1 of *Molecular Pharmacology*, edited by E. J. Ariëns, justifies the notion that pharmacology is more than a basis for therapeutics, that it is a science in its own right. In this first volume of a planned four-volume treatise, the molecule becomes the functional unit in the search for explanations of drug action. Although the drug molecule is, in almost all cases, a well-characterized entity, the complexes or configurations in the organism with which drugs interact are almost without exception poorly defined or unknown. Because we do not have definitive information concerning the nature of the objects that interact with the drug, pharmacologists have found it necessary to introduce the descriptive term, *receptor*, in order to discuss drug action on a molecular level. Just as physicists found the concept of the neutrino necessary to account for certain atomic phenomena and geneticists used the concept of a gene to organize and describe their experimental data, pharmacologists have found the receptor a valuable model around which the descriptive data of pharmacology could be systematized and theories of drug action constructed and experimentally tested.

This volume, which consists of five essays written by G. A. J. van Os, A. M. Simonis, J. M. van Rossen, and Ariëns, is an exhaustive treatise on drugs, receptors, and their interactions. Receptor theory has made it possible to bring a large variety of experimental observations under a common denominator, and thus the theory has served and continues to serve a purpose. The book is logically and effectively organized into three sections. Section 1 deals with the processes that determine the concentration of the drug in the biophase at the receptor site.

Section 2, the major portion of the book, is concerned with drug-receptor interactions of various types and varying degrees of complexity. There is a detailed discussion of classical structure-activity relationships, and emphasis is placed on the inherent difficulties involved in the attempt to understand the totality of intermolecular processes occurring between drug and receptor molecules on the basis of conventional "blackboard" chemical formulas. A more sophisticated view of the molecule, which includes the spatial arrangement of atoms, the charge distribution, and the relative location of reactive groups, is called for. The dose-response relationship which is fundamental to pharmacology is analyzed in great detail. Questions of competitive interaction, drug affinity, intrinsic activity, and stereospecificity, as they relate to the interaction of the drug with receptors, are also considered. The physicochemical nature of the receptors is dealt with insofar as it is known. It is somewhat poignantly pointed out that whereas with enzymes it is possible to use highly purified preparations which may retain their enzymatic activity, receptors can only be studied *in situ*—that is, as a part of their natural environment since no stimulus can be induced on an isolated receptor.

Section 3 deals with nonlinear and complex relationships between stimulus and effect, such as all-or-none responses and threshold phenomena. Questions of drug sensitization, tachyphylaxis, tolerance, resistance, and cumulation are also considered in this section.

One of the principal virtues of this work derives from its organization. The theoretical basis of each topic is first

developed and then considered in the light of the available experimental evidence which supports or contradicts the theory. Terms, which are all too often loosely used, are here rigorously defined. Absolute statements are generally avoided. The entire volume is detailed and documented with over 1000 references. It is recommended as a valuable book which may well become a classic in the field of pharmacology.

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Physics

Introduction to Advanced Field Theory. G. Barton. Interscience (Wiley), New York, 1963. x + 163 pp. Illus. $6.50.

There are several approaches to a relativistic quantum theory of elementary particles. When the covariant perturbation method of the Lagrangian field theory met with difficulties, notably in strong (nuclear) interactions, attempts were made, beginning about 10 years ago, to study the essence of field theory independent of a perturbation approach, or even independent of a Lagrangian. This book is an introduction to what has been achieved along that line of inquiry. The fundamental concept is still that of a *field* through which the interactions of fundamental particles are expressed, contrasted to, for example, the pure S matrix approach, which uses directly observable particle properties, momenta, spin projections, and the like to define an S matrix. The very indirect and unobservable nature of a *field* becomes clear in the first two brief chapters when Barton, starting from the particle properties ("Everyone knows that in no experiment is a field ever observed directly"), introduces free fields by definition, and, later on, using an asymptotic condition, defines the so-called interpolating fields in describing the interactions of particles. The interpolating fields go over in the limit, when the particles are widely separated from each other, to the free fields. Despite the fact that the field concept is definitely a mathematical abstraction, carried over from classical physics, we do not understand the quantum theory of fields well enough to see its limitations. In this sense one would like to see what can and what cannot be done by starting with some general and reasonable postulates about the fields. Unfortunately, it is outside the scope of this little book to connect these general principles with the actual physics of fundamental particles; not even some very general results such as the CPT-theorem and the connection between spin and statistics could be included. On the other hand, the book provides a very clear and readable introduction to these general aspects of quantum field theory. An index and a more detailed bibliography would have been useful.

The connection to the conventional field theory is discussed in chapters 3, 4, 5, and 6 (Green's functions and inhomogeneous wave equation) and in chapters 7 and 8. These chapters are followed by a discussion of the general properties of the simplest diagrams, the so-called two- and three-point functions, and by a lengthy discussion of the Lee model. This is a simple soluble, perhaps not too realistic model, on which however some of the properties of field theories can be studied explicitely. The next chapter deals with special problems created by the systems with an infinite number of degrees of freedom. Finally, in the last chapter, Wightman functions and Haag's theorem are briefly discussed. Here one comes to the limitations, or better to a decision, about some of the seemingly reasonable assumptions about the fields. For the assumption of canonical equal time commutation relations and the absence of inequivalent representations of these rules lead to the unphysical result that only free fields can exist. No final solution to this dilemma is presented.

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Psychology

Motivation: Theory and Research. C. N. Cofer and M. H. Appley, Wiley, New York, 1964, xii + 958 pp. Illus. $12.50.

Thirty-five years ago, while I was enrolled in a course entitled Motivation, a professor-friend of my instructor seriously asked me if there was enough factual material on motivation to justify the title or, for that matter, the course. The answer given was a hesitant, "I suppose so." Today the answer would be a quick affirmative followed by a suggestion that the enquirer have a look at Cofer and Appley's *Motivation: Theory and Research.* Although the authors of this volume modestly say that ". . . a comprehensive, definitive psychology of motivation does not yet exist," they actually have a production that has little in common with the texts and research materials of yesteryear. A notion of the enormity of the changes in this field may be gained from the book's 96 pages of bibliography, a spot check of which indicates that 70 percent of the entries are research reports. Furthermore, in this new book one does not find enumerated for memorization such past fantasies as Overstreet's six ways of capturing attention, McDougall's ten principal instincts, Dunlap's nine fundamental desires, Allport's six prepotent reflexes, Tolman's eight appetites, and other similar circularities. Instead, in eight chapters are presented extensive experimental findings arranged under such headings as bodily conditions, activity, emotion, stress, and reinforcement. Five chapters summerize numerous case records and naturalistic observations under rubrics like instinct, self-actualization, and psychoanalysis. The other three chapters are introductory, historical, and summary.

The organization of the book is really achieved in connection with three current views or theories of causes of, and factors that control, behavior—namely, instinct, homeostasis, and hedonism. A portion is concerned with ethologists' work directed toward discovering energy releasers for fixed behavior called instinct. Next comes the major part of the work, which bears on the notion that living organisms, especially mammals, possess a disposition to achieve and maintain a balanced or homeostatic equilibrium. The remaining material is that which is traditionally regarded as affective or hedonistic. The authors view the homeostatic or equilibratory concept as having widespread utility for motivation, but their own preference for a motivational theory is a variant that they call sensitization- and anticipation-invigoration mechanisms. Thus, invigoration is the key, and it occurs when bodily states or conditions deviate from previous ones. In such states, an organism