tion because the translation of these terms into English, especially English legal concepts, inevitably distorts through implying whatever range of meaning the English words carry in their usual, nonethnographic use. Bohannan is fully alive to the difficulties his view involves, and he believes that within the next ten years the problems of translation of basic concepts will be eased, but not wholly solved, through the development of an "independent and logical language," perhaps of the sort used with computers. This language will be part of the apparatus needed to make useful comparisons among different folk-systems as they are experienced by those who live with them.

It is obvious that both Gluckman and Bohannan are seeking worthy ends. It is less obvious why Bohannan cannot use the same sort of empirically based and strictly limited terms Gluckman does. Bohannan appears to find ordinary operational definition inadequate as the basis for his system of description and analysis, and despite his invoking of Fortran and, elsewhere, some of the methods of modern linguists, it is not clear how he proposes to proceed without employing the same basic definitional procedure Gluckman and other scientists do.

Taken together the papers in this book make a noteworthy assembly. One or two are not of first quality, and a synthetic introduction or conclusion would have added greatly to the virtue of the volume, as would a more careful proofreading of the error-strewn text. These are cavils, however, and this book is a stimulating and important one.

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A Philosophical Analysis of Einstein's Theories

Axiomatization of the Theory of Relativity. HANS REICHENBACH. Translated from the German edition (Braunschweig, 1965) and edited by Maria Reichenbach. University of California Press, Berkeley, 1969. xxii, 210 pp., illus. $7.95.

The logical and epistemological foundations of Einstein's theories of relativity have continued to interest scientists and philosophers for over threescore years. This book is a lucid translation of a classic work in the philosophy of science, which was first published in 1924. It attempts a philosophical analysis of those theories by presenting them in carefully wrought axiomatic form.

The author precedes his articulation of an axiom system for the special theory of relativity with a terse discussion touching on the role of different types of definitions in axiomatizations, the relation of the axioms to experience, and the epistemological foundations of the concept of time. In the first part of the book Reichenbach presents an axiom system for the "light geometry" of special relativity, from which he obtains the Lorentz transformation equations relating different inertial frames of reference. He then introduces the "matter axioms," which specify the behavior of rigid rods and clocks, which he takes to represent the metrical behavior of material objects. The axiomatization of the general theory of relativity, which is the subject of the second part of the book, is constructed on the basis of the axioms and definitions of the special theory by requiring that the latter hold in infinitesimally small space-time regions, and by also adding an axiom concerning accelerated clocks and rods together with six new definitions.

The book is a most useful contribution for students of the philosophy of space and time, and also for those who are interested in the history of logical empiricist philosophy. Much of the book is presupposed in Reichenbach's influential monograph *The Philosophy of Space and Time*, first published in 1928 and in English translation in 1957, which utilizes his above-mentioned axiomatization in the construction of the space-time metric, but which does not re-present the details of that axiomatization. The book under review also contains a carefully delineated account of Reichenbach's explication of time in terms of causal chains.

Though the book is a most worthwhile contribution to the literature, the axiomatization it presents has been criticized several times. Not long after the German edition appeared, the physicist H. Weyl pointed out that the light geometry axioms were not sufficiently restrictive. More specifically, the light geometry axioms do not eliminate a non-Lorentzian "similarity transformation" without an appeal to a hypothesis about material objects, say a rigid rod or a clock. Reichenbach appears to have accepted this criticism in his later work, where he admits that unless one is to appeal to the behavior of light signals at infinity, a move which Reichenbach found objectionable on physical grounds, one must have recourse to an assumption about material objects in order to exclude the similarity transformation:

$$x_i = \frac{x'_i}{x'^2_1 + x'^2_2 + x'^2_3 - x'^2_4}$$

(Here i ranges from 1 to 4, x'_1, x'_2, x'_3 refer to space dimensions, and x'_4 to the time dimension multiplied by the velocity of light.) Accordingly the presentation of the theory of relativity given in the *Axiomatization* should be read in the light of the author's later, modified accounts.

Reichenbach's analysis also contains a number of philosophical assumptions which are currently considered somewhat dubious. The discussion of the axiomatic method, and the defense of it as the "only method that will reveal the logical structure of the theory with perfect clarity" and allow for a clear distinction between the "empirical and logical components of assertions," are questionable in the light of serious difficulties pointed out by W. V. Quine and H. Putnam in distinguishing between analytic and synthetic assertions. Further, Reichenbach's belief that his inquiry "starts with elementary facts as axioms" and his claim that "all axioms of our presentation have been chosen in such a way that they can be derived from experiments by means of *pre-relativistic* optics and mechanics" are likely not to be accepted by contemporary philosophers. Partly this is so because of the demise, in the philosophy of science, of any simple distinction between theoretical and observational language which would permit the expression of such "elementary facts," and partly because pre- and post-relativistic optics and mechanics are now thought to be quite inconsistent with one another. Accordingly, one would suspect either that Reichenbach's premise concerning the *derivability* of his axiomatization of relativity from pre-relativistically characterized experiments is wrong, which is my own view, *or* that the axiomatization plus sentences describing its experimental base involve a self-contradiction.

The inter-theoretical inconsistency between pre- and post-relativistic optics is blurred in Reichenbach's account both by his implication that light geometry was relativistic *prior* to Einstein's 1905 analysis, and by his explicit assertion that the revolutionary contribution of Einstein's special theory of relativity consisted in asserting that light geometry and matter geometry are identical (see pp. 14, 76). Though it is true that the subject matter of physical optics, in its Maxwellian form, is in an *objective sense* Lorentz-invariant prior to Einstein's analysis, that is, that Maxwell's equations are invariant under Lorentz transformations for space and time parameters, it is not the case that such Lorentz invariance is guaranteed by straightforward inductive generalization based on the results of the Michelson-Morley interferometer experiment of 1887. In papers published in 1899 and 1904, Lorentz was able to accommodate the Michelson results in the context of his "absolute" theory by means of his asymmetrically interpreted contraction effect together with his then experimentally sanctioned *approximation* to complete Lorentz (actually Poincaré and Einstein) invariance. Thus Reichenbach's exposition here does not distinguish sharply between the Lorentz absolute theory and Einstein's relativistic theory, though Reichenbach does do so, as regards the different contraction effects, in his 1928 monograph. It seems again that Reichenbach's epistemological analysis of 1924 must defer to his later work for historical fidelity as well as for logical adequacy.

As a final related epistemological point, I might note that Reichenbach cites as the experimental support for his axiomatization of relativity only an inductive generalization of the Michelson experiment (see p. 93), though he does indicate that a test of the transverse Döppler effect, later observed by H. Ives and reported by the editor in the notes, would be of import as well. The characterization of the relation between theory and experiment which Reichenbach has given obscures the historical fact of the variety and wealth of the evidential base of the Einstein special theory, discussed, for example, in M. Laue's 1911 text *Das Relativitätsprinzip*. Laue mentions, among others, the aberration experiments of Airy, Fizeau, and Rayleigh and Brace, the electrical experiments of Röntgen, Eichenwald, Wilson, Trouton and Noble, and Trouton and Rankine, and the high-velocity electron experiments of Kaufmann and Bucherer. Though there may be some gain in elegance in erecting the theory of relativity on the narrowest experimental base possible, it is doubtful in the light of the remarks above whether Reichenbach has succeeded in doing so, and further it is also unfortunately likely that he has misrepresented the extent of the contact between theory and experiments in this case.

In sum, this book, if read in conjunction with the author's later work, should be of considerable value to students of the philosophy of space and time, particularly to those working in the Reichenbachian-Grünbaumian tradition, as well as to those philosophers who are oriented toward the articulation of the formal structures of scientific theories.

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Hypothalamic Structure and Function

The Hypothalamus. WEBB HAYMAKER, EVELYN ANDERSON, and WALLE J. H. NAUTA, Eds. Thomas, Springfield, Ill., 1969. xvi, 808 pp., illus. $45.

This massive compendium, like the work with the same title that was published in 1940 under the aegis of the Association for Research in Nervous and Mental Diseases, brings together specific monographs by a number of the outstanding leaders in more recent investigations of the hypothalamus. The result, the first attempt at a comprehensive treatment of this subject in nearly three decades, is a monumental and beautiful book, fit to take its place beside the older volume.

The editors, who are also contributors, have selected the authors with care. As in the earlier work (edited by Fulton, Ranson, and Frantz), the topics covered are diverse; practically all major areas of investigative effort are ably represented in the 18 chapters. An instructive short chapter by Evelyn Anderson sets the tone by exposing some of the (sometimes tragicomic) processes through which scientific "truth" has been arrived at in the past, revealing both impediments to progress designed by nature and those marshaled by the all-too-human psyches of investigators whom later generations have come to view as paragons of scientific objectivity.

This is followed by a group of seven chapters which deal primarily with various morphological aspects of the hypothalamus and its components, as well as with the anatomy of related parts of the central nervous system. The subjects covered range from ontogeny through gross and comparative anatomy and vascular architectonics to nuclear organization and the synaptic connections that form the basis of most interneuronal information transfer. Included here is a superbly written chapter by the late John D. Green on the hypothalamo-pituitary linkages through which the nervous system can adjust pituitary function in response to exteroceptive and interoceptive stimuli.

Green's chapter leads logically into a set of five chapters dealing with a subject on which the earlier book had only tantalizing prophecies to offer—the neural control of pituitary function. The 1940 book had two chapters (by C. M. C. Brooks and U. U. Uotila) suggesting that the pituitary stalk might have some necessary role in maintaining gonadal, thyroid, and adrenal function. The present volume contains four substantial chapters (by A. V. Nalbandov and J. Graber, G. W. Harris and R. George, C. H. Sawyer, and the late Leon Desclin) in which the mass of newer information on anterior lobe function is skillfully and selectively reviewed, as well as a lucid and well-proportioned chapter on the neurohypophysis (by M. Pickford). These chapters present a nice balance among various points of view. Some sections fairly pulse with the energetic arraying of evidence that the adenohypophysis is "under the control" of the hypothalamus. Others—without denying what is known in support of this relatively recent view (that the adenohypophysis, like an autonomic neuron perhaps, exists but to execute orders from the brain)—gently raise firm caveats: "The 'control' is not universal, here are some exceptions. Now, what is the true picture?"

Considerations of hypothalamic function in the earlier book were dominated by analyses of those processes the physiologists of the time could assess: regulation of temperature, food and water intake and water balance, motor activity, sleep. Investigations of these processes have multiplied and, blessed by the advent of electronic technology, waxed increasingly sophisticated. Yes-