FOUNDATIONS

OF

NEUROPSYCHIATRY

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Dedicated to

WILLIAM GORDON LENNOX, A.M., M.D., S.D.

Colleague, Critic, and Friend
and now in this Sixth Edition
to him and
all Those Others
who began as my pupils
and
became my teachers

FOREWORD

Thirty-four years as a teacher of second year students in neuropathology has taught me a great deal. Because of the awesome complexity of the nervous system, one must emphasize principles and leave out much factual material. In short, one must simplify and schematize; frankly, of course. The anatomy and physiology of the brain should be taught with the pathology. In the official curriculum each may be put into a separate compartment. For effective teaching they are inseparable.

The book is written to give to practitioners and students of medicine the facts and correlations needed to understand the simpler workings of the central nervous system. In truth, little more than these simple mechanisms is thoroughly understood, and even some of these are still controversial. Thus, adherence to principles that are fairly well established has kept the book small, for it has been my aim to mention only those anatomical structures the physiology of which is known, to discuss only physiological processes for which there is a fairly well substantiated anatomical basis, and to describe only the pathology that has fundamental significance. References are given for the reader who would study details. The book is a preface, to start the student with a three dimensional orientation towards neurology and psychiatry—a brief, concurrent anatomy, physiology, and pathology leading up to a description of some of the principal disease entities.

S. C.

PREFACE TO THE SIXTH EDITION

In the preface of the fifth edition, it was noted that there had been so many advances between 1948 and 1952 that a large part of the book had to be rewritten. This is equally true of the last four years. Feed-back and central modulation of sensory perception have changed one's comprehension of the physiology of reflexes. Neurochemistry has become an important field and bids fair to revolutionize neuropathology. At the present writing, only the broad outlines have been sketched in Chapter I and some special chemical investigations have been referred to in Chapters VIII, IX, X and XI. The recent experimental and clinical work on the brainstem and centrencephalic system has led to changes and additions to Chapter VI. A discussion of pain, as the most important single topic in medicine has been introduced into Chapter III. In Chapter XIV, suffering is discussed, and some of the human reactions to pain are viewed in this setting. The opportunity to work closely with Drs. J. C. White, William Sweet and Frances Bonner on problems of intractable pain, gave the impetus to the writing of these new passages. At the end of Chapter XIV the author hopes he may be permitted to enjoy his short flight into philosophy where he expounds the monistic point of view towards medicine.

To the various colleagues who have helped me with their suggestions, and criticisms, I offer my sincere thanks, especially Drs. M. A. B. Brazier, Byron Waksman, E. P. Richardson, Bertram Silverstone, Alfred Pope, Charles Kubik, J. C. White, and W. G. Lennox. Working together has been a joy, so I can say with Chaucer, "And gladly wolde he lerne and gladly teche."

STANLEY COBB

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INTRODUCTION

Neurology is the study of the central nervous system and its far reaching neurons in the peripheral nerves. Neuropathology is more particularly the study of the processes that cause abnormality in these structures. Since the brain is the organ of mind, one can state in an analogous way that psychology is the study of the mind, and psychiatry the study of the abnormal mind. Obviously, for the student to understand any one of these subjects he must have a working knowledge of all four. The present task is to review enough of the normal fundamentals so that the brief descriptions of the disease processes are intelligible.

In this year of 1957, however, the definitions given above are too simple to be accurate; the terms are not definable in any way that will meet with general acceptance. Psychology and physiology are two disciplines with many overlapping problems and data. One of the greatest recent advances in psychology was made by Pavlov, a physiologist who would not admit that psychology was a science! Neurology and psychiatry obviously have many fields in common, but some neurologists and psychiatrists tend to draw apart from each other and leave a no-man's land between their domains. Only a few hardy leaders among neurologists really master this field where perceptions begin to have *meaning* and where deficits cause agnosia, apraxia and amnesia. Many modern psychiatrists are so busy trying to puzzle out how to study "the patient as a whole" that they have to call a neurologist to analyze an aphasic disorder. The use of the word "mind" brings up a host of problems as to what processes are mental, what is consciousness, is consciousness the same as mind? New points of view are continually emerging and disturbing the neurologist and psychiatrist who had too soon settled themselves into orthodoxy. All this unrest is wholesome and stimulating, but it is at first very confusing to the student. For the purposes of this introductory book, I shall have to admit that many terms are not now definable and leave it to the common sense of the reader to grasp my meaning.

The problem of neuropsychiatry is a great one; nervous and mental diseases probably have about seven million victims in the United States today; the number of patients with severe psychoneurosis is very difficult to discover but it probably adds several millions to the 7 million estimate. The economic burden is enormous and is apparently increasing; it is imperative to learn more about the causes of these diseases so that therapy may be improved. When one undertakes the study of neurology, psychiatry, and neuropathology, his practical aim is the cure of nervous and mental disorders. The field is so broad, however, and includes such a variety of problems, that it is well at the beginning to visualize clearly the relationships of these three to other branches of science and to one another (1).

A diagram may illustrate the relationships between psychiatry and certain other sciences (fig. 1). Psychiatry is represented as a pyramid, its apex being philosophy and its base physics, anatomy, and chemistry. Any other science could be similarly schematized as a pyramid; for each the apex would be philosophy and the base would be made up of the more exact sciences in which measurable data are used. Putting all these completed pyramids together, apex to apex, would make a polyhedron containing all knowledge; it would have a shell of science and a core of philosophy. For the psychiatric pyramid one may indicate anatomy, physics, and chemistry as the ultimate though remote supporting blocks. Built on these are blocks of physiology, neurology, experimental psychology and pathology. These studies are all basic and are well founded on controllable observations. If one wishes to build higher, to things mental, one must leave above these fundamentals a wide hiatus, because of a void in present knowledge that makes investigation in human psychology and psychiatry difficult to control scientifically. So in this pyramid the mental sciences lie above the void, indicating that they are as yet

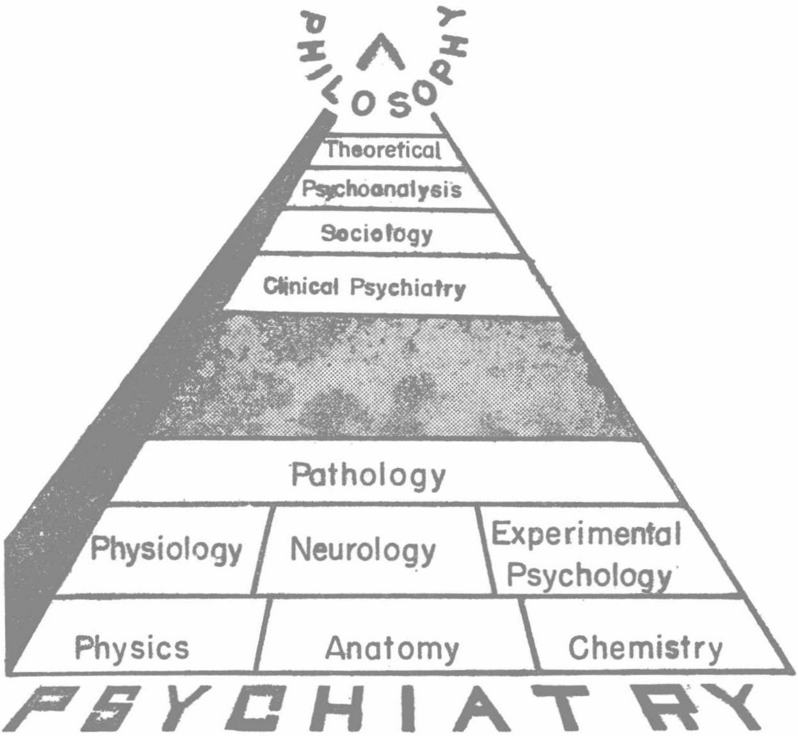

FIG. 1

only feebly supported by the fundamental sciences. Psychiatry, nevertheless, has accumulated a great many data by observation. The psychiatrist knows much about what occurs in abnormal minds, but little about why and how it occurs. Psychoanalysis, though of recent birth, has also accumulated a mass of observations, but these are even less controllable than the data of general psychiatry, because the slowness of the method makes difficult the collection of large numbers of cases.

Theoretical psychology has a place in the pyramid above psychoanalysis, leading to the most abstract and universal of all subjects, philosophy, at the apex.

When these disciplines or departments of study are arranged in this way, one important principle immediately becomes apparent: the divisions between departments are purely arbitrary. For example, anatomy, physiology, neurology and experimental psychology differ from each other merely in emphasis and methods. The divisions are necessary for administrative purposes in a university or in a hospital. Further than that they mean nothing. They have no biological significance. Too often one hears even mature physiologists say, "But that is psychological—" as if departmental lines absolved them from thinking, and from realizing that much psychology is nothing but a more complex physiology, in short, cerebral physiology rather than the physiology of the nerve-muscle preparation. For example, much work done in departments of psychology is classifiable as experimental neurology and three of the greatest contributions to psychiatry of the last fifty years have been made in physiological laboratories: Pavlov's work on conditional reflexes, Cannon's investigation of emotional reactions, and the recent work on the brain stem by Magoun, Hess, Jasper, and Penfield (2). Medical sociology is recently taking its place in psychiatry. One cerebrum does not function alone in society so the effect of one active brain upon others must be studied; the study of interpersonal relations is becoming increasingly important in psychology and psychiatry.

But to return to the void in the center of the psychiatric pyramid. It is here that research must be carried on for many years in order that block after block of facts may be built up to explain the observations and to support or refute the theories now promulgated in psychiatry and in psychology. Many of these theories are probably correct. Indeed, correct explanations are often discovered years before proof is available.

Charcot, Freud, Janet, and Prince seem to have hit on truths; their formulations are supported by clinical evidence, but at present their theories have little support in experimentally controlled observations. This is no reason for saying, however, that accurate, controllable methods never can be applied to the observation of human behavior. It is because the science of psychiatry is young that it seems too complex for qualitative analysis. All sciences pass through an infancy in which qualitative analysis alone is possible (3). Seventy years ago neurology was just beginning to be recognized as a science; with extraordinary rapidity the main facts have been learned, first by anatomical methods, later by physiological. Neurology may have a pyramid of its own or may be used as a support of psychiatry, for psychiatry is the oldest of the medical arts but the youngest of the medical sciences. Perhaps this is because at the top of its pyramid it merges much with philosophy, deals with that vague thing we call "human nature," and sometimes seems to be suspended from above and a bit off its solid base.

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Chapter I

SOME GENERAL PROBLEMS OF ANATOMY AND PHYSIOLOGY

The basic anatomical structure of the nervous system is the neuron. It is composed of a cell body with long processes, the axon and the dendrites. The whole is covered by a cell membrane. The cell body contains a nucleus and a nucleolus. In the cytoplasm are also found neurofibrils, mitochrondria and large blocks of chromophilic substance known as Nissl bodies.

Nissl first described these in 1892 and his cresyl violet stain is still used to show their variations in size and distribution. The metabolism of nerve cells is almost entirely dependent upon carbohydrates brought to them in the rich capillary bed. Casperson (1) proved, however, that protein is also metabolized during nerve cell activity, and pointed out the great importance of the nucleoproteids, identifying some of them by microchemical methods. Enzyme studies are also being done so a useful picture of chemical action in the nerve cell is being put together. When this is accomplished, one will have a much better understanding of the nature of the nerve impulse, the electroencephalogram, and such abnormal discharges as those which cause fits.

In 1860, when the general cellular theory of tissue structure was young, the nerve cell and the axon were thought to be separate structures. Weigert's staining methods proved the continuity of the nerve cell and the axon in 1871, and Bethe's intravital methylene blue stain demonstrated this even more clearly in 1875. It was thought by some good microscopists, however, that the axons formed a continuous network, and that the neurofibrils passed from one neuron into the next.

This conception was not borne out by the beautiful silver preparations of Ramón y Cajal and Bielschowsky (1903). By 1900 most anatomists had accepted the three essentials of the neuron theory: 1) that each neuron consists of a cell body together with the protoplasmic outgrowths, axons and dendrites; 2) that transmission of impulses is in one direction only—dendrite to cell body to axon, and 3) that the neurons are the structural units of which the nervous system is composed and that they stimulate each other by contact at the synapse. This all seems so obvious now that one can hardly understand the long controversy. It was Harrison's definitive demonstration, in 1910, of the growth of axons out from nerve cells in culture that finally quieted all argument.

THE NERVE IMPULSE

The electrical theory of transmission of the nerve impulse is now generally accepted. Its slowness of conduction and discontinuity is explained by the fact that transmission of the impulse is the result of local electrical circuits flowing between inactive and active portions of the nerve. Each local circuit acts as the exciting agent for the next adjacent segment of resting nerve. In other words, the nerve impulse is a reversible electrochemical reaction in which the nerve fibers within their membranes behave like core conductors (2). The chemical change is in the ratio of the concentration of the potassium and sodium ions inside and outside of the axon, the membrane of which is semipermeable. Sodium ions enter the fiber at the moment of excitation, and potassium leaks out.

One must beware, however, of the too facile comparisons of the nervous system to electrical systems. They have led to confusion and an unjustified belief that the nerve impulse is an electrical current. It is unlike such a current because the energy for the transmission of the impulse is derived from the nerve itself and not from the stimulus. Also the nerve impulse is a discontinuous process with a slow rate of transmission of the order of 30 to 130 meters per second.

The chemical theory of transmission postulates that the sudden formation of acetylcholine causes an increase in permeability of the axon membrane with a fall in resistance and resulting depolarization. The acetylcholine is then destroyed by cholinesterase and polarization is then restored. Such a process was thought by Nachmansohn to take place from region to region along the axon. It is still the best explanation of transmission at the synapse (3).

At the neuromuscular junction cholinesterase is found in greater concentration than elsewhere in the muscle, and the junction is exceedingly sensitive to acetylcholine. Probably the current flow that stimulates the muscle fiber is dependent for its development upon the formation of acetylcholine, which is inhibited by the enzyme cholinesterase. Thus the transmission at the neuromuscular junction is a special phenomenon and cannot be used as a prototype for transmission of the nerve impulse in the axons.

NEURON CIRCUITS

The concept of reverberating circuits within the central nervous system has been of primary importance in bringing physics and mathematics to bear on neurology. Forbes in 1923 first suggested that neurons connected so as to make circuits might have important physiological functions. In 1930 Kubie pointed out the great theoretical implications of closed circuits. The anatomical basis was found in the beautiful silver preparations of Ramón y Cajal. Finally the work of Lorente de Nó from 1934 to 1947 brought both physiological and anatomical methods to bear on the problem and provided the data needed by Wiener (4) and his associates to develop "Cybernetics." Before this time the general conception of function within the nervous system was based on the picture of the telephone exchange—input coming from sense organ along a line of neurons to central exchange, and out again along another line to the effector organ. It is now realized that this only roughly and inadequately schematizes the main afferent and efferent neuron systems. Practically all long axons in brain and cord have branches which go to short collateral neurons. These are called internuncial or intercallated neurons. Their cell bodies are small and their axons are relatively short. They are the small nerve cells plentifully seen in any section of the brain or cord, and they are far more numerous than the conspicuous larger nerve cells with long, main-line axons. A branch from an axon may play back upon the cell of origin, or, more commonly, play upon several small internuncial cells and through their axons, and secondary relays reach the next efferent cell in the main chain. There are thus series of small nerve cells, beside the larger main tracts, with short collateral axons forming many synapses, circuits and nets. These cause varied delays of the nerve impulses and comprise a mechanism for summation, facilitation, after discharge and inhibition. Mathematicians like Wiener and mathematically minded physiologists like McCulloch were quick to see the analogy of the electronic computing machine to reverberating circuit mechanisms in the brains of animals. Brazier (5) says that this change in concept of the nervous system is so great that it is almost impossible to overestimate it. In brief it is a change from the concept of a passive, static nervous system to an active dynamic one.

Until the cybernetic theory was promulgated, memory had never been explained by any reasonable physiological theory. Even now it is only a theory. The essential postulate is that a neuron circuit may be set in action by an incoming single impulse and that the circuit may go on reverberating as long as metabolism supports it, or until other incoming impulses change it. In the electronic computing machines one circuit is set to modify the behavior of the others in response to a certain signal. The circuit stores that reaction; it has been set and the setting manipulations are the essential past experience. It chooses the proper signal when it comes, having rejected all