SCIENCE

FRIDAY, MARCH 1, 1912

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

NEW PHRENOLOGY[1]

A HUNDRED years ago, when Gall and Spurzheim published the results of their work, the anatomy of the brain was poorly understood, and the explanations of the relation of its parts, or of the relation of the brain as a whole, to mental states and processes, were interwoven with absurd fancies or with quibbling speculations. There were many guesses postulating definite functions for large areas or divisions of the brain. The assumptions and suppositions were combated and defended mainly by logical methods, and, because of religious and other *a priori* views, direct observation and experimental methods took a subordinate position. What was lacking to make one or another of the various views acceptable was a series or collection of vitalizing facts that could be utilized or adduced in its support. The importance of the cerebellum was magnified by some; it was believed to be the seat of memory, or that of the so-called higher intellectual faculties. The basal ganglia were also thought by others to be concerned with the intellectual processes, whether as the structures or storehouses in which memories were collected or as the element involved in the processes of thought. Even the ventricles had been suspected of being the seat of certain intellectual functions, although it is probable that this view had no direct adherents at the time Gall began his investigations.

The foundation for Gall's work and teaching has been laid by Reil and others

[1] Address by the president of the Southern Society for Philosophy and Psychology, Washington, December 28, 1911.

who had previously taught the supremacy of the brain itself, and who had regretted the lack of knowledge of the anatomy of this important viscus. In support of their views, a few observations could be cited of patients who had lost particular functions, such as sensations, or the ability to move or to speak, when the brain was injured. The associations of these losses with brain injuries had rightly led some to believe that the brain is an organ with diversified functions. Many of the adherents to this view held, however, "that one can not explain the loss of certain intellectual faculties in certain cases except by admitting that the brain is composed of many partial organs," and also that "the smallest parts of the brain have special functions."

Gall, as he remarks in the preface to the work on the "Anatomy and Physiology of the Nervous System," had made numerous observations of the relation of facial, cranial and mental characteristics, and the hypothesis of diversified functions for different brain areas well fitted his own views. This was the origin of physiognomy and of phrenology. The mind, it was supposed, is composed of a collection of units, of mental states or faculties which differ from one another in degree or in kind. It was presumed, therefore, that some localized part of the brain was concerned with each of these supposedly different states and processes, and, consequently, it was believed that it should be possible to find definite brain centers which are associated with, or which produce by their activity, different mental processes. Thus was born a definite conception of centers in the brain for particular mental acts. This conception was naïve and crude, to be sure, but it is the one which has dominated neurology and nervous physiology for the past century, and which is still to be recognized in present-day teaching and writing.

This view led to various attacks and defences, bombardments and counter attacks, which were usually futile in advancing the knowledge of the relations which were discussed but which were indirectly of the greatest value in the advance toward a better understanding of the relation of clinical phenomena to brain lesions. The discussions led to observations and to careful comparisons of material so that the doctrine of exact localization of centers was not new at the time that Broca startled the neurological world with the report of the relation of a definite brain lesion with the loss of the ability to speak.

The rigid localizations of Gall and the vagaries of Spurzheim and his imitators were not received with entire confidence and faith, but the conception of one function for one part of the brain was too simple and too alluring to be dispensed with. Instead of the general formula that the brain is the organ of mind, divisions were introduced and both the brain and the mind were fractioned. Observations of other aphasic conditions with concomitant cerebral lesions were recorded and the strict localization view continued to be dominant. Wernicke and his disciples stood on the platform with Gall, and discussed learnedly of concept and percept centers and centers for motor images in the cerebral cortex. It was supposed that the recently announced discovery of Fritsch and Hitzig afforded evidence of this for the motor sphere and the precise localization in the cortex of definite centers for sensory processes by various physiologists made many certain that the hypotheses underlying phrenology were correct. All were compelled to admit the principle of cortical cerebral localization, but the meaning of localization proved to be an apple

of discord (*e. g.*, the discussions between Munk, Goltz, *et al.*).

There were some who disputed the functional dismemberment of the brain, and withstood the establishment of spatial localizations for definite mental functions, but their voices were not listened to or their facts were denied, or their arguments disregarded. They contended that the clinical and physiological facts gave no warrant for a localization in parts of the cerebral cortex of mental functions as such, and furthermore they pointed out that the cortical centers did not operate independently, and that functions could not be considered apart from the totality of the elements involved.

The schematism of phrenology was, however, too alluring; it gave a definiteness to diagnosis, and it satisfied certain other practical and theoretical desires. Criticisms of this view from the psychological standpoint were laid aside, but since many of the clinical facts could not be fitted to the anatomical divisions, other evidence was sought. The myelogenetic studies of Flechsig were hailed as witnesses to support the contention of the anatomical localizations of mental processes. The developmental differences of Flechsig's fields (now forty in number) of the cerebral cortex were received with gladness, and were used as additional splints and crutches for the doctrine. But even this was not sufficient. Anatomical localization of the mental faculties could not be made certain without additional support and it is within the past few years that our latest contributions to the doctrine of phrenology have appeared. These may be described in brief as the histological localizations of mental processes.

It was discovered that certain areas of the cerebrum differ both macroscopically and microscopically from other areas, and the careful examinations of the cerebrum led to the division of the cortex into a number of areas, which were considered by the observers to be quite distinct from one another.

Elliott Smith made a careful examination of the naked eye appearances of all regions of the cerebral cortex and found that the streaks of light and shade differed in parts. The conclusion was drawn that these appearances indicated differences in the arrangement of cells or fibers in the cortex and that the cerebral cortex could, consequently, be divided into these anatomically distinct areas. Campbell and Brodmann used finer methods, those of histology, and discovered that the cerebral cortex could be divided into areas, which had the cells collected in different groups, or which had different sizes of cells, or which had the fibers arranged in characteristic ways. Depending upon the methods which are used, the number of these histologically and macroscopically distinct areas varies from about eighteen to fifty. It does not appear to make much difference that the histologists are not in accord in regard to the number of the histologically distinct areas, or in their exact individual location, the important point appears to be that certain areas are anatomically distinct, sufficiently so, that they may be recognized by their histological and gross appearances.

These areas, because of their differences in structure, are supposed to have different functions. Brodmann has given the clearest pronouncement regarding the supposed functional value of these observations. He has written: "physiologically unlike parts have unlike structure," and "parts of organs which differ structurally must have different functions."

In these statements we have the entering wedge for a more complete phrenology than has been advocated since the time of

Gall. If each of these areas, histologically distinct from one another, has an individual function distinct from the functions of the other areas, we should also have a similar number of mental functions or faculties to correlate with them. Unfortunately for our purpose, the histologists have not attempted to give us the mental correlates of all the anatomically distinct areas, although in a few cases the anatomical reasoning and connections have led to certain psychological suppositions. It is in this way that we must account for the psychic areas of Campbell, and for some of the other psychological localizations which have been made.

An example of this anatomical reasoning is that of Campbell regarding the distribution of the sensory areas. In areas which were believed, because of the physiological and clinical evidence, to have sensory functions, Campbell observed that certain fibers "pursue a curious oblique course" different from other fibers in other neighboring areas. On the basis of this fact Campbell constructed other sensory areas, these latter areas being endowed by him with mental (*i. e.*, sensory) functions because in this one particular they had an appearance similar to that in supposedly known sensory fields. It did not appear to make any difference that these areas might have other well-marked differences. The main anatomical point is that these oblique fibers were discovered in different regions, and the important psychological point is that these minor similarities have been interpreted as indications of similarity of function of a mental order. In this case, Gall has been surpassed, and his phrenological reasoning outstripped.

The designation by Campbell of psychic areas, surrounding the so-called sensory areas, are interpretations of a phrenological nature of a supposed functional connection of the primary receptive areas with these and of a relation of these areas to mental processes. In this there is a distinct psychological interpretation that the nervous impulses which start from the sense organs reach a part of the cerebral cortex and give rise to sensations, and that other nerve currents are sent to neighboring areas and give rise to perceptions.

Let us glance for a moment at the cortical area posterior to the fissure of Rolando. Campbell divided this region into two distinct zones (the postcentral and the intermediate postcentral) which are believed to be concerned with the afferent impulses from the skin and the underlying tissues. The zone bordering on the fissure, the postcentral, Campbell designates as "sensory," and that adjoining the first area "perceptive." In the first area the sensations of touch, of temperature, of pain and of movement are localized, and in the adjoining area (the intermediate postcentral) there are the psychic functions of localization of touches and also the so-called stereognostic sense. If we consider only the postcentral sensory area of Campbell, we might ask: Why should the same brain area be concerned with such unlike sensations as those which he attributes to it? By histological-phrenological reasoning we should have four, or even eight, distinct areas. Even though the gross sense organs have been differentiated, taste and smell, as sensations, are as much alike as are touch and pain and temperature and we might on anatomical grounds, if we closely follow Campbell, expect them to have seats in the same area. The observations of Cushing upon the effects of excitation of the postcentral area in conscious patients have not helped this attempt at a definite mental localization, and, in fact, they are decidedly opposed to it.

The motor area of the brain has been the

easiest for the anatomists to deal with, and it is the one to which they least often impute mental functions. In this connection, however, it is of interest to examine some of the evidence relating to this area to see how well its functions have been determined. In man this area is anterior to the fissure of Rolando, and is not simple. The cortex adjoining the fissure is to be differentiated from another anterior part and to these areas Campbell gives the names precentral and intermediate precentral. The primary part, that bordering upon the fissure, is the precentral, and this, according to Campbell, is bounded anteriorly by the other zone, which is physiologically connected with it. Stimulation of the cortex of the precentral area produces movements, and it has been a simple matter to explain the function by assuming that the cells govern the bodily musculature. But movement is also produced when the intermediate postcentral and other parts of the cortex are stimulated, and the latter movements are the more complex. In the precentral cortex the Betz cells are those to which the motor function has been imputed. These cells differ in number and in size in different parts of the precentral cortex, and these differences have been supposed to indicate functional differences, the use of the larger ones being variously interpreted as (*a*) indication of large movement, (*b*) of the extent of the nerve fiber or (*c*) of the number of muscle fibers which each controls. But differences in the sizes of these cells in the two hemispheres have been observed by Betz, and the larger size of those in the right hemisphere can not be explained in any of the ways that have been suggested. The Betz cells are reported to be absent in the guinea-pig, rabbit and rat, and we have no reason to suppose that these animals lack the ability to move or to coordinate their movements. The recent studies have not usually been taken to suggest that the motor area is the seat or storehouse of motor memories, and in this respect there is a marked avoidance of a phrenological opportunity. Since the area is one of the most distinct histologically, and since it is one in connection with which extensive clinical and physiological observations have been made, it is of special interest that the histologists have been unable to explain in a satisfactory manner the reasons for the anatomical variations. Here, again, I would interpret the observations of Cushing and others on this area differently from Professor Pillsbury, who concludes that these results point to the non-mental function of this zone. We are not able to limit the localization of mental processes in this way, and, on the other hand, I do not believe that these observations can be interpreted as indications of a mental localization.

There are other facts which must be considered in relation to the localization of supposed mental functions in the motor area. The principal one is the phenomenon of nerve anastomosis. If two motor nerves are cut and the distal part of one be connected with the central part of another, and, conversely, the central part of the first be joined to the distal part of the second, there may be a return of function after a period of paralysis. We have no right to assume any anatomical alteration in the brain connections to account for this change, and the phenomenon has been interpreted, probably correctly, as a transfer of function. If this is to be interpreted in relation to any cerebral mental localization, it must surely be considered negative evidence.

In regard to some of the other so-called sensory fields we have almost as much information as regarding the one supposed

to be concerned with the sensations of touch, pain and temperature. Regarding the localization of mental states in these other areas, we have other suppositions which are to be believed as much as that regarding the mental functions of the post-central area. One of these, that the layers of the cortex in the so-called visuo-sensory sphere function to produce sensations of different color is a more bizarre supposition, and has even less clinical evidence in its support.

Many neurologists and some psychologists appear to believe that we have data which enable us to locate certain definite mental processes in parts of the cerebral cortex outside of the motor and sensory spheres. The disorders of speech, of the nature of aphasia, which are considered by some to be mental abnormalities, are due to localized injuries or destructions of parts of the brain. That the third frontal convolution, the area to which Broca assigned the function of motor speech, has a different structure than the surrounding regions, as has been contended by Brodmann, is a point made in favor of the localization of the speech function in this area. The criticisms of von Monakow and of Marie are, however, too trenchant to be disregarded, and the negative cases which they have cited are sufficient evidence that neither the mental processes connected with motor speech nor the supposed cortical speech mechanisms are definitely located in the part of the brain to which they were assigned by Broca, by Wernicke and by their followers.

One of the histologists has written: "It is unfortunate that we can not say that word deafness is invariably due to a lesion of the left superior temporal gyrus. Authentic cases have been recorded in which there has been no affection of this convolution and these, of course, increase our difficulty in interpreting the condition." In another place he admits that the localization of this condition, even as a clinical phenomenon, rests upon only two cases which have been checked by careful post-mortem examination. Disregarding the number of cases which may properly be cited in support of the localization of this part of the speech function in this part of the cortex, it should be remembered that even one negative case is sufficient to demolish the whole structure of the mental speech function localization.

On the basis of the histological studies, we have also another kind of phrenological localization. This is a localization of particular processes of a mental order in certain layers of cells in the cortex. It will be remembered that the cortex is composed of rather distinct layers of cells with their fibers. Some histologists believe there are six layers, others five. Some of these layers have been disregarded in the formulation of the speculations. Bolton and Ariens Kappers believe that the layers have receptive and associative functions. Bolton disregards the first and fourth layers (he counts only five instead of six, as does Brodmann) and postulates the following functions for the other three layers: for the outer pyramidal layer he assumes a "psychic or associative function," for the third layer a receptive function, and for the fifth layer the function of lower voluntary and instinctive activity.

These facts indicate the general trend of the histological localization of function, and its tendency toward phrenology. What shall we say against this view or what shall be our attitude towards it? Brodmann assumes that the principle of localization has been settled, and all that needs to be done at present is to consider the "how" and "what" of localization. This view can not, however, be accepted.

It is the principle of localization which must be debated and settled. Whether it is the mental processes or cells which are localized is a matter which apparently the histologists and clinicians have not settled. It may be admitted that cells and cell groups are localized, and, although there is some doubt on the part of some clinicians, we may be willing to admit that certain symptoms are produced by definite lesions. We have, however, no evidence which will warrant the conclusion that mental states have been localized, and it is doubtful that many psychologists will believe in the crude histological localization of mental processes. The histological, the physiological and the clinical evidence warrants only a belief in the possibility of an association of brain lesions with motor, sensory and associational derangements, it does not warrant a belief in psychic localization.

Although it is apparent that mental states are not to be found spatially associated with definite areas distinguished from one another by histological and macroscopical characteristics, for practical purposes we must admit a close connection between the brain and mental processes. How then shall we conceive of the relation between the activities of the brain and mental states? The functions of the nervous cells, as functions, may include something which is at the basis of psychological states, but at the present time the physical and chemical activities of the cells can not be believed to be equivalents of the mental processes which may be concomitant with or the result of these activities. Since for practical purposes we may need some general principle of localization, we may say that mental processes are not due to the independent activities of individual parts of the brain, but to the activities of the brain as a whole. Here also I would not omit the cerebellum. It is well known that similar mental processes may be inhibited by or may be lacking because of lesions in parts of the brain widely separated. This fact is the one at the basis of the diaschesis hypothesis of von Monakow. This hypothesis explains only certain clinical manifestations; it explains certain losses and how the same symptoms may be produced by diverse lesions. Conversely, it helps towards a proper understanding of the brain processes in connection with mental states. The individual parts of the brain do not work independently; they work interdependently, and it is because of the possible functional and anatomical connections that certain types or kinds of mental states are more in evidence than others. We should, on the physiological side, be not far wrong, if we compared the brain to a village or city as did Gregoire of Nice. There are paths and streets, definitely related to one another, but each independent to a certain extent. There are broad roads with many travelers, there are paths only occasionally traversed. There are houses from which the people come and to which they go; some pouring forth people in streams, others only occasionally; to some numerous people go and to others few. What goes on in the houses we can not tell. We can observe the "from" and the "where," the structure of the houses, and numerous other anatomical and histological facts, the effects of blocking of paths and streets and the destruction of houses, but the purposes of the travelers we do not know. We may have for the city a histological and a clinical localization, but this does not mean that we have also a mental localization.

From the anatomical and physiological standpoint, we deal solely with associations of an anatomical and physiological character. With these physiological associations mental processes are supposed to be

correlated. It is not necessary that we shall conclude that all of the mental processes are associational, and we must, in fact, admit that retention, and possibly other factors, in memory are not of this character. What memory means physiologically we do not know; where memories are stored we do not know; and how they are stored we do not know. All that we do know is that certain disturbances of the brain are accompanied by certain mental abnormalities, and that similar mental abnormalities are produced by or accompany diverse lesions. We have no facts which at present will enable us to locate the mental processes in the brain any better than they were located fifty years ago. That the mental processes may be due to cerebral activities we may believe, but with what anatomical elements the individual mental processes may be connected we do not know. Notwithstanding our ignorance, it would appear best and most scientific that we should not adhere to any of the phrenological systems, however scientific they may appear to be on the surface. We should be willing to stand with Brodmann, believing that mind is a function or an attribute of the brain as a whole, or is a concomitant of cerebral operations, but I at least am unwilling to stand with the histological localizationists on the ground of a special mental process for special cerebral areas or for special cerebral cell groups.

Shepherd Ivory Franz
Government Hospital for the Insane

PROFESSORSHIPS IN CHINA

We are requested to state that several teaching positions in the Imperial Pei-Yang University, Tientsin, China, are likely to be open as soon as stable conditions are restored in China. Applications should be sent to President S. H. Wang, Imperial Pei-Yang University, Tientsin. An application should contain: (1) a cable address so that the applicant can be engaged by cable, if necessary, (2) a full statement of qualifications, especially practical and teaching experience, (3) age of applicant and other personal details, so that, in the absence of an interview some idea of the personality of the applicant can be obtained. The Imperial Pei-Yang University is the provincial University for Chih-li (the province which contains Peking), and its position in the educational system of China is similar to that which the state university of a correspondingly important state in the United States would occupy. This does not mean that it is comparable to the University of Wisconsin, for example. The university, founded in 1895 by Dr. Chas. D. Tenney, was destroyed in 1900 and rebuilt in 1902. Its present president is Wang Shoh-lien, a noted Chinese educator and man of affairs, a graduate of Woolwich, England. Of the numerous schools which are eventually to constitute the university only three have yet been organized, Law, Civil Engineering and Mining and Metallurgy. In 1910 the foreign staff consisted of two professors of law, three professors of civil engineering, one professor of mechanical engineering, a professor of history and economics, a professor of chemistry, a professor of mining and geology, and a professor of metallurgy, in addition to a numerous staff of Chinese professors and other officers. The courses of study in these schools are similar to those in American technical schools, but, as can readily be understood, the conditions surrounding the work are somewhat primitive, and makeshifts are often necessary. Nevertheless, Columbia University and the University of California have recognized the completion of the course in this university as equivalent to attaining the B.S. degree. A description of the university and its work can be found in *Engineering News* (one of the numbers during the autumn of 1910). All the work in technical subjects is done in English, though many of the students do not speak English with much ease or fluency. In some respects the equipment is quite complete, and in others it is lacking. The students are at