Prince (M) with Compliments

HOW A LESION OF THE BRAIN RESULTS IN THAT DISTURBANCE OF CONSCIOUSNESS KNOWN AS SENSORY APHASIA

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HOW A LESION OF THE BRAIN RESULTS IN THAT DISTURBANCE OF CONSCIOUSNESS KNOWN AS SENSORY APHASIA.[1]

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WHEN Broca demonstrated that an injury to the base of the third frontal convolution on the left side of the brain caused a loss of the power of speech, the first step was taken towards the exact localization of the functions of the brain. But though all subsequent experience has confirmed Broca's discovery, more recent clinical observation has shown that this region is not the only one the integrity of which is essential for the function of language; but that the destruction of other regions, as, for example, the Island of Reil, the first two temporal and other convolutions, result in the impairment of this faculty. But, on the other hand, while it has been shown that this is the case, it has also been determined that there are differences in the symptoms presented according as the impairment of speech is due to an injury to Broca's convolution, or to some other spot. In other words, all aphasia is not the same, but that the faculties retained and lost by

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aphasics differ; some for example can perfectly understand when spoken to, but cannot articulate or write; others can articulate, but cannot understand a single spoken word though they hear perfectly all other sounds; others can both understand spoken language and speak, but their speech is unintelligible; and so on. Various attempts accordingly have been made to construct a number of different types of aphasia, to which all cases may be more or less approximated. To understand the phenomena of aphasia it is necessary to carefully study the faculty of language as possessed by a normal individual. I have no intention of doing so here, further than to point out that for the complete faculty of speech, which is a complex function, the co-operation of at least three different functions is requisite. In the first place, it is necessary to be able to hear the sounds of words, internally as well as externally; for a person may be deaf to *words*, though he has most acute hearing for all other sounds. Secondly, there must be a sufficiently normal intellect, in order that words may be combined with ideas; and thirdly, we must be able to co-ordinate the motor impulses to the muscles of the apparatus of speech. Clinical observation has further shown that these different faculties are distinct and separate, and that one can be lost while the other two are retained; but that the impairment of any one, whether of the acoustic, the motor, or the intellectual faculties, results in an impairment of speech, or aphasia. We are thus compelled to distinguish different centres in the brain corresponding to each of these functions—namely: an acoustic centre where the sounds of words alone arise; a motor centre, where the impulses to the muscles of speech are co-ordinated; and a larger and diffuse centre for the intellect proper, where the word-sounds are associated with ideas. As the impairment of the intellectual centres comes within the domain of insanity it need not concern us further here. When the motor centre is affected, the resulting disturbance of speech is known as *motor*, *ataxic* or *Broca's aphasia;* when the acoustic centre is at fault, as *sensory* or sometimes *paraphasia*. These are two of the principal forms of aphasia. Other forms have

been distinguished, but it is not necessary for my purpose to consider them here.

Motor aphasia is the most common form. I will not trespass on your time by narrating cases of this well known type, but will briefly mention the following case, in order that the type may be contrasted with the second variety.

A young woman, Hannah D., had an attack of apoplexy two years and five months before I saw her, and following an attack of rheumatism and probably endo-carditis. At the time of my examination the right hemiplegia, which at first had existed, had entirely disappeared. Aphasia only remained. The only improvement of speech since the attack consists in the ability to say "No." She cannot say "Yes." She can understand perfectly when spoken to. She can write her name but nothing more. She can read to herself, but not aloud. She cannot repeat spoken language.

In this case there was:

LOST:	RETAINED:
a. Volitional speech,	*f.* Understanding of spoken language,
b. Repetition of words,	*g.* Understanding of written language.
c. Reading aloud.	
d. Volitional writing,	
e. Writing to dictation.	

(She could write to dictation "Boston" as far as "Bo," but not Massachusetts or any thing more.)

Various schemes have been constructed to diagrammatically represent the mechanism of the different forms of aphasia. I may say here that, in my judgment, none of the many thus far constructed correctly accord with all the phenomena of aphasia, though the one given by Lichtheim is probably in the main correct. I have drawn on the board so much of it as is necessary for the purposes of this paper. This is probably correct so far as it goes. The intention is merely to schematically represent the different centres concerned in speech and their connection, without reference to what portion of the brain they are located in.

a. is the auditory nerve which carries acoustic impressions to the centre A., where the word-sounds arise. B. is the centre for the intellect proper. M. the motor centre, and m. the motor nerves. A. B., B. M., and M. A. are commisural fibres connecting these centres.

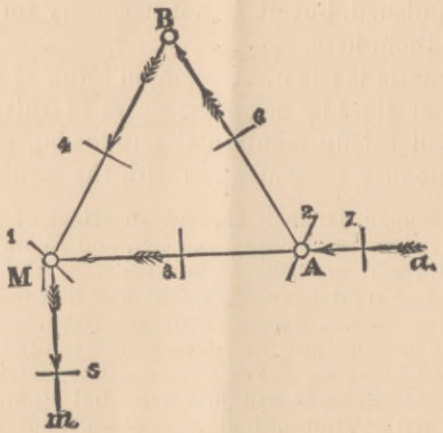

Fig. 1.

From a study of this scheme, if correct, it is apparent that seven different types of aphasia can *theoretically* occur, according as there is an injury to the centres A., B., M., or their connections.

Lichtheim claims to be actually able to distinguish clinically these seven types. Be that as it may, the scheme enables us to understand the mechanism of the commonly recognized forms. In the motor form, of which I have just spoken, the centre M., where the motor impulses to the muscles are co-ordinated, is destroyed. Hence ideas in B. cannot resolve themselves into words. On the other hand we can understand how such a patient can readily understand when spoken to, as the auditory centre A., the intellect B., and the connection A. B. is intact. He might be able also to think in words, to write (?) and read (for simplicity's sake I have not represented the centres for the latter two faculties), though he could not repeat words dictated. If the centre A. alone is destroyed we have the second form of aphasia I spoke of, namely, sensory aphasia. In such a case, though the patient can *hear all other kinds of sounds*, he is absolutely deaf to words. As B. and M. are intact the faculty of volitional speech is retained, but it is so modified that the patient uses the wrong words, and puts together syllables belonging to different words in such

a way as often to make his sentences unintelligible. He has what is called paraphasia. He can properly co-ordinate the motor impulses so as to pronounce all the sounds of a language, but words and syllables are combined in an unintelligent manner, owing to the defect in the word-consciousness at A.

The following case of sensory aphasia has been recorded by Wernicke:

> The patient was an old woman who was thought to be insane, and accordingly sent to the insane asylum. There it was found that she was perfectly sane, but, though her hearing was acute for sounds, as tested by a watch, *she was stone deaf for words*—that is, she understood absolutely nothing that was said to her. Although she could speak (thereby differing from the motor aphasic), her language was often meaningless, from the fact that she inserted wrong words in her sentences, and often distorted and senseless words. The meaning of her language, however, could be unravelled, and was found to be rational.

It is this form of aphasia, where the consciousness of the sound of the word is lost—sensory aphasia—which I propose to more fully consider here to-day. That there is a centre in the brain where the sound of the word is generated there can be no doubt. The case which I have just narrated to you conclusively shows this. This centre is distinct from that one where the the motor impulses, which control the articulation of words, originate, and the destruction of which results in ataxic or motor aphasia. In the diagram these centres have simply been indicated with their connections, without attempt to define their actual locations in the brain itself. In regard to their actual locations we are not yet prepared, perhaps, to express an opinion for all the centres. The motor centre without doubt is situated in the posterior third of the third frontal convolution, known as Broca's convolution, and its neighborhood, in the region marked A. (Fig. 2). Pathology has clearly demonstrated this. The auditory centre, on the other hand, is less firmly established, though there is reason to believe that it is in the neighborhood of the Sylvian fissure in the first temporal convolution.

Another case given by Wernicke points to this fact. It was that of a woman who was supposed to be crazy and

deaf, but was found to be also suffering from word deafness and paraphasia. At the autopsy there was found a thrombolic softening of the first and of a great part of the second left temporal convolution (Fig. 2, shaded portion).

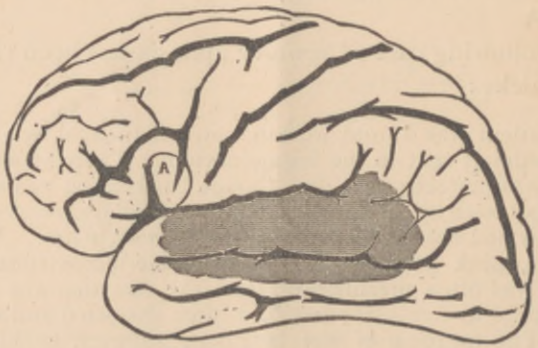

FIG. 2. (After Ferrier.)

Now, the question which I am coming to is this: What do we mean by a centre for speech? How does it happen that a destruction of this centre causes a loss of the power of speech, and in particular a loss of the power of hearing words? In answer, you say that here in this temporal convolution is the spot where the word-sounds are generated, and when this spot is destroyed, the apparatus is destroyed which generates the word-sounds. This is what is implied or hinted at in much of the language of medical text-books and periodical literature. If you will pause for a moment to reflect you will perceive that such language means either very little, or something which is so carelessly expressed as to border on nonsense. Can you conceive of the brain generating a sound as a gas machine generates gas? If you can, what manner of thing is the sound, and what becomes of it after it is generated? Any notion of word-sounds, or any other form of conciousness being a *product* of the brain, is too crude to bear analysis. The moment you try to picture the process to your mind you are lost in a sea of contradictions.

If one is more exact in the use of language, he says that the acoustic centre for words is the spot where the activity

of the brain is *accompanied* by the auditory sensations of words, and the destruction of which centre results in the loss of the faculty of understanding language, or thinking in words internally. But again it may be asked: *How* does the destruction of the brain end in loss of word-sounds? and *why* should the sounds be gone simply because the brain is injured? You have broken up a circumscribed piece of the brain; but do you see any likeness between that piece of brain and the sound of a word? The sound is a form of our consciousness; why then should it not exist though the brain be broken? You may answer that it is the function of this part of the brain to—— Do what?—*produce* word-sounds? This brings us back to the difficulty of conceiving of a sound as something produced. Can you not conceive of your having sounds without a whole brain? Why, then, I repeat, should the consciousness of words be gone because a spot of brain is broken up? Examine this piece of brain as much as you please. Bring your microscopes to bear; dissect it till you have made out that it is made up of cells and nerve-fibres, of connective tissue and blood-vessels; analyze it in your chemical laboratory till you discover it is composed of protoplasm, of myelin, of fibrin, and what not. Increase the power of your lenses till you see the very molecules of protoplasm as they beat against one another in the myriads of cells of the brain, and after you have done all this, have you found any where any thing like a sound?

But sound is the *function*, you answer, of the brain. Well, look again through your microscope. Watch the blood course through the vessels; watch it transude through the walls of these vessels into the cells; watch it transude back again after its chemical constitution has been metamorphosed. Look into the cells themselves, and watch the very molecules as they vibrate in unison; watch them, as the vibrating wave passes along the ingoing nerves into the cells, and watch how the wave passes out again as the molecules in the outgoing nerves take up the motion. Watch again the molecules as they combine and recombine in new proportions with the new food brought by the blood, and

see others cast out as effete products of metamorphosis. You have now seen the *function;* have you come across any thing like the sound of a word? Where then does this sound come in? It is this question which I have brought before you for your consideration to-day, and which I shall endeavor to answer.

Let us look a little more closely into what happens when an artery, for example, breaks in the brain. The cortex of the brain, as you know, is made up of cells and fibres. As a result of the rupture, the cells are disintegrated and the fibres severed. Along the latter neural currents are no longer carried, and in the cells nervous "force," so-called, is no longer generated,—the molecular vibrations which accompany a state of consciousness, as the sound of a word, can no longer occur.

If we had examined more minutely the cells before they were broken up, we should have found that they are principally made up of nervous protoplasm, a very complex substance. We know that it is made up, like all material substances, of molecules, the smallest particles into which a substance can be divided without changing its composition. The activity of a nervous cell consists in the vibration of its composite molecules. It is this activity which accompanies the word-sound.

But still in viewing this activity, we have not yet got any nearer to the word-sound we are in search of. Let us go a step farther and examine what we mean by a molecule, and by molecular vibrations. A molecule is something which we picture to ourselves as having a certain shape and size; if, in imagination, we press it between our fingers, we perceive it has a certain density and hardness; we must regard it also as having a certain color similar to that of a large mass of the same substance. Furthermore, when acting in conjunction with other molecules we know it has a variety of physical and chemical properties. Its properties, as a whole, may be described as the resultant of the properties of its constituent atoms.

But when we say that a molecule of protoplasm is of a certain color, shape, and size, etc., etc., what do we mean

by this? When we say that the molecules of protoplasm vibrate with one another what manner of thing is this vibration? There is more in this question than seems at first sight. To answer it we must turn to our physiology, and inquire how it is that we see objects, and how it is that we recognize a molecule to have color, for example. What we shall find to be true of seeing, will also be found to be true of all our other senses.

I am going to represent here on this blackboard by this star-shaped figure (Fig. 3, *a*) a molecule of protoplasm, which we will suppose is in a cell in the brain *A*.

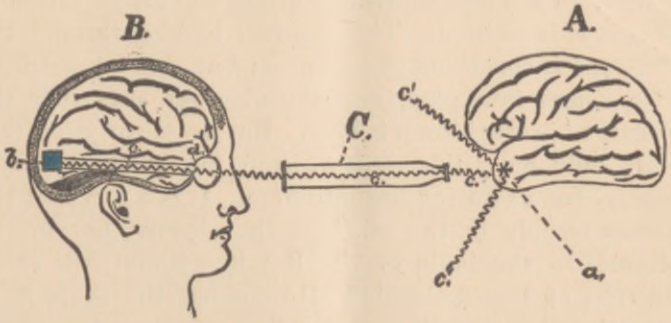

FIG. 3.

We will imagine a person, *B*, inspecting it through the microscope, *C*. The observer makes out that there is something there *that is octagonal in outline, and blue in color*. What is the physiological process by which he sees all this? Physics and physiology answer thus: The vibrating waves of the ether, *c'*, *c'*, coming from the sun are reflected, *c*, *c*, *c*, through the microscope, *C*, toward the eye, of the observer, *B*. After passing through the cornea, lens and vitreous humor of the eye they impinge upon the retina, *d*. If we pause a moment to consider what has occurred we may be surprised to find that nothing like color, or shape—indeed, nothing like a picture of a blue octagonal molecule, thus far exists. So far the only phenomena presented are oscillations of the molecules of ether between a point, *a*, and the retina; but now the motions of the etherial molecules are transmitted to the retina, and to the molecules of

the nervous protoplasm in the optic nerve. Along the optic nerve, along its prolongations, deep into the brain, the motion is continued, till the waves reach the occipital lobe of the brain; here the cells of the cortex are at last reached, and to the molecules in these cells the motion is communicated. Even then, till we reach these cells, nothing like color has appeared. Sever the lines of communication at any point between *a* and the cells of the cortex and nothing like color exists, though the molecules of ether around *a* are still in agitation. But at last the motion has been transmitted to the cells in the cortex of the brain, and now, for the first time, color arises, and the sensation of blueness, *b*, is excited. The observer looking through the microscope is conscious of blueness; but now an artificial device comes into play, and the observer says that the molecule of protoplasm *a* is blue. But we see at once that this is only an artifice, the reasons for which it is not necessary for us to inquire into here. It is a fact that the blueness is only in the mind of the *observer*, not in the molecules in the brain of *A*. But how about the other properties of this molecule? How about the shape? A moment's reflection will show you that this, too, exists only in the mind of the observer; and is produced there by rays of undulations of ether being transmitted from each point of the molecule (*a*), and falling upon the retina, exciting there again as with color, vibrations amongst the molecules of the optic nerve; as before, no picture of the molecule has yet arisen, nor again does it arise till the motions in the nerve have been communicated to the cells of the cortex where, for the first time, a picture of the molecule, consisting of a certain outline and surface of an octagonal figure *b*, is formed.

What is true of color and shape is also true of hardness and the other qualities possessed by the molecule. Hardness is only a sensation derived by touch, and also has its origin in the brain of the observer. But after we have abstracted these qualities from the molecule what remains? That there is something there which excites these sensations in us there can be no doubt. Something remains be-

hind; what it is we do not know. But there is something there; some unknown force or activity you may call it, but its nature is unknown. This unknown something we call the *Reality* of the molecule, because it is the molecule as it really exists independent of the sensations of color, etc., it excites in us. It is called the molecule-in-itself, or the Reality. I want you to bear in mind what I have endeavored to explain is meant by the Reality of the molecule, in order that what will follow may be understood.

We must still go one step farther. We have learnt what is meant by molecules. We have learnt that the "Realities" of molecules are unknown "forces."

You will remember that it was said that when the molecules in the cells in the temporal convolution were set into vibration, one with another, that the sound of a word arose in consciousness. Now what is meant by "vibration of molecules"? To answer this we must again turn to physiology. Turning again to our diagram, it will be perceived that just as the *color* of a molecule exists only in the mind of the observer, so the *vibration* of these molecules is likewise only a sensation, and this sensation also occurs in the observer's brain, when he brings his microscope to bear on the cells in the convolution. This sensation, called a vibration, does not occur in the temporal convolution of A, but in the second person's mind (B). It is excited in B by something that occurs in A, just as the sensation blue is excited by that something called the Reality of the molecule. What is this something which creates in the observer the sensation of molecular undulations? This in turn is the *Reality of the undulations.*

Now the nature of the Reality of the molecules we admitted was unknown to us; is the Reality of the undulations of the molecules also unknown to us? My answer is, "No." It is known to us. What is it then? *It is the word-sound* we have been in search of. The conscious state which we call the sound of a word is the Reality of the vibration of the molecules in the cells of the first temporal convolution. Such is the explanation which I desire to present to you. The data upon which this conclusion rests I cannot enter

into here. I have already done so at length in another place, and must refer such of you as desire further proofs of this assertion to that work.[1]

My intention is to offer you that explanation which in my judgment best explains how it is that when the first temporal convolution is destroyed word-deafness results. When this injury is inflicted, these molecular vibrations, and of course the Realities of these vibrations, cannot occur.

Those of you who have followed me thus far must have already perceived that the explanation, which I have endeavored to make clear, is not limited to the single question of aphasia, but is far more wide-reaching and general in its principles. It embraces the great question of the relation of the mind to the brain, and explains the connection between the two. It shows how consciousness arises as the resultant of material factors, and how an impairment of the cerebral functions means also an impairment of consciousness. It shows how the physiological activity of the brain and consciousness are one and the same thing, and that any imperfection in the physical working of the former, means an imperfection of the mind, and an imperfection of the mind means an imperfection of the brain. We may say with certainty that wherever we meet with an impaired mind, whether that impairment be either only temporary or permanent, there is also some derangement in the physiological working of the brain. This theory therefore assumes a practical value.

Some may be disposed to think that though we may have found a mode of explaining the relationship between the mind and the brain, still it is only a theoretical question without practical utility. To this I wish to make emphatic objection. In the first place it is a *physiological* question, and therefore one the elucidation of which enables us to understand the *modus operandi* by which disease of the brain is manifested in a disordered mind; and any thing which does this must aid us in the comprehension of mental pathology. In proof of this I have only to allude to the general ideas widely prevailing regarding certain functional diseases, such as hysteria.

[1] "The Nature of Mind and Human Automatism." J. B. Lippincott Co., 1885.

In former times, not so many centuries ago, either, the unfortunate person afflicted with insanity was said to be possessed by an evil spirit, and was loaded with chains, cast into a cell, and sometimes even punished with tortures that the evil one might be driven out. Improved knowledge in physiology and pathology of the body has resulted in the scientific and humane treatment of the present day. But something of the old ideas still clings to hysteria. An invalid, usually a woman, complains of pain, of suffering, of disordered functions of every form. Her character and disposition are changed from what they were. The physician examines her, finds no coarse anatomical lesion to account for the symptoms, and turns away with the remark: "It is only hysteria." The patient says she is in pain. The physician says again, sometimes even contemptuously: "It is only hysterical." And every one around the patient says nothing is the matter. How different all this becomes when we regard every symptom, even the thought which prompts a patient to exaggerate her symptoms, as synonymous with disordered physiological activity! If we bear in mind that every symptom in functional diseases of the nervous system means disordered activity of the cells and fibres; that every deviation in the mental activity of the patient, every change of disposition and character, even the absence as well as the presence of former modes of thought, means an imperfect working of the brain, whether by the inactivity of some cells or the too great excitation of others, we shall better comprehend the pathological condition of our patient.

If space permitted, it would be interesting to notice how this conception of the mind and the brain makes thoroughly comprehensible many facts hitherto inexplicable, and often regarded as mysterious; facts which because inexplicable are oftentimes received with credulity. I refer to the influence of the mind upon the body both in health and disease. The influence of the mind in modifying the physiological processes of the body is a well-known fact; that it can also modify pathological processes of minor grades is a fact, which, though tardily acknowledged by the profession, is from time to time made use of by empirics and im-

postors for their own material advantage. The well-known metallic points of Perkins, which nearly one hundred years ago reaped such golden harvests and which now adorn the wall of our medical library, as a reminder not less of the power of the mind over bodily processes than of the credulity of human nature; the bread pills of our fathers; the *placebos* of modern medicine and the epidemic mind-cure of to-day, which like the dancing mania of the Middle Ages, threatens to entice the whole population into its folds, all attest the power of the mind upon the body. A knowledge of the nature of the mind and its relation to the body allows the intelligent physician to distinguish the true from the false, to extend the boundaries of mental action to the farthest limit of its own domain, as well as to set restrictions to its encroachments made by shallow and credulous believers.

In attempting to elucidate the connection between aphasia and the anatomical lesion of the brain, I have thought that the time has come when the physician should not limit his investigations to mere broken fibres and degenerated cells, on the one hand, nor to mental symptoms, alone, on the other, but should ask the nature of the bond between them.

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