

## ON THE NATURE OF THE DUALITY OF THE BRAIN.

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I GIVE here a résumé of some of the opinions I have expressed during the last seven or eight years on the nature of the duality of the brain.

That the nervous system is double physically is evident enough. This is a very striking fact, but one so well known that we are in danger of ceasing to think of its significance—of ceasing to wonder at it. A truth becomes a truism. The chief significance of the duality lies, I think, in its bearing on what is most fundamental in mental operations—the double process of tracing relations of likeness and unlikeness.

The nervous system, I repeat, is physically double. I wish to show that it is double in function also, and further, in what way it is double in function. I shall speak of the brain only, taking illustrations, however, from the lower parts of the nervous system.<sup>1</sup>

Not long ago few doubted the brain to be double in function as well as physically bilateral; but now that it is certain, from the researches of Dax, Broca, and others, that damage to but *one* lateral half can make a man entirely speechless, the former view is disputed. Thus, Broca and Moxon suppose that but one half of the brain—the left in the vast majority of people—is educated in words, the function of the other half not being developed in words.

Prior to the researches of Dax and Broca it might have been supposed that the brain was double in function in either of two ways: (1) That action of both halves was required in any mental operation; (2) that either half (indifferently) would serve alone. Neither of these opinions can now be held, with regard to words, at any rate. The two halves are not double in function in the sense that *both* are required for speech, since a patient can speak perfectly well when the *right* half of his brain is damaged, in whatever part the damage is, and how extensive it may be. Nor are they double in the sense that the two halves are such exact

<sup>1</sup> I use the word "brain" to include the cerebral hemisphere and the subjacent motor and sensory tract. I use the word "encephalon" to include all parts of the nervous system within the skull. It is convenient to use the word "half"—meaning a lateral half—when speaking of the nervous system, and "side" when speaking of the body. Thus, disease in the left half of the brain produces paralysis of the right side of the body.

duplicates that *either* of them will do for speech, since extensive damage in a certain region of the *left* hemisphere will destroy speech altogether.

Speaking in more detail, we say that, in the vast majority of cases, extensive damage to the brain in the region of the corpus striatum on the left destroys speech, and that equally extensive damage in the corresponding region on the right does not affect speech at all.<sup>1</sup> The reader will observe that there is no expression of opinion as to the very exact part of the brain injury of which produces loss of speech. Whilst I believe that the hinder part of the left third frontal convolution is the part most often damaged, I do not localize speech in any such small part of the brain. To locate the damage which destroys speech and to locate speech are two different things. The damage is, in my experience, always in the region of the corpus striatum; but in this article it will suffice to speak of the half of the brain affected; it is admitted that there are exceptional cases; loss of speech has occurred from damage to the region mentioned on the right, and the region on the left has been damaged without any affection of speech. *But the matter of most significance is that damage to but one hemisphere will make a man speechless.* This no physician denies, so far as I know.

I shall suppose in what follows that loss of speech results from damage to the *left* half of the brain, although it matters nothing for the argument which half it is. It is enough that there is in every man one half, be it right or left, damage of which will make him speechless.

Contradictory as it may appear at first glance, I think the facts of cases of loss of speech from damage to but one—the left—half of the brain show conclusively that, as regards use of words, the brain *is* double in function. But the very same cases show also that the two hemispheres are not *mere duplicates* in this function. I hope to show two things—(1) that both halves are alike, in so far that each contains processes for words; (2) that they are unlike, in that the left only is for use of words in speech and the right for “other processes in which words serve.” We shall afterwards show that these expressions are only used to mark extremes of degree. Anticipating what has to come, we say that the right hemisphere is the one for the *most* automatic use of words, and the left the one in which automatic use of words merges into

<sup>1</sup> In this article I illustrate by cases of *loss* of speech, not by cases of *defect* of speech, I do this for the sake of simplicity. As will be mentioned later in this paper, there are numerous varieties and degrees of defect of speech from different degrees of damage to different parts in the region of the corpus striatum.

voluntary use of words—into speech. Otherwise stated, the right is the half of the brain for the automatic use of words, the left the half for both the automatic and the voluntary use. The expression I have formerly used is that the left is the “leading” half for words (speech). We must now say what we mean here by speech.

Speaking is not simply the *utterance* of words. The utterance of any number of words would not constitute speech. Speaking is “propositionizing.” To this meaning the term speech must be rigidly kept.<sup>1</sup> That the speechless patient cannot propositionize *aloud* is obvious—he never does. He cannot propositionize internally. He can neither say “gold is yellow” aloud nor to himself. The proof that he does not speak internally is that he cannot express himself in writing. He may write in the sense of copying writing, and can usually copy print in writing characters. Now, if he can speak internally, why does he not write what he says to himself? He can say nothing to himself, and therefore has nothing to write.<sup>2</sup>

For its *character as speech* it matters nothing whether the proposition be said to oneself or spoken aloud. Anatomically and physiologically regarded, we say that the *same* nervous processes are concerned in internal as in external speech. The difference is that the excitation of these nervous processes in speaking to oneself is so slight that the nerve currents developed do not spread to the articulatory and vocal muscles; in speaking aloud the excitation is strong, and currents do reach those muscles. This fundamental similarity and superficial difference between internal and external speech must be kept well in mind.

So, then, the speechless patient has lost speech, not only in the popular sense that he cannot speak aloud, but in the fullest sense; he cannot propositionize in any fashion. If this be really so, we must not say that speech is external thought, for there is no essential difference betwixt internal and external speech. We speak not only to tell other people what we think, but to tell ourselves what we think. Speech is a

<sup>1</sup> It is evident enough that there is much behind speech; a proposition is but an end of a series of mental processes and a beginning of another series. But these things do not concern us just yet.

<sup>2</sup> In cases of *defect* of speech there is *difficulty* in writing. In some cases of defect of speech there remains considerable power of writing. I know that cases of *loss* of speech have been recorded by eminent physicians, in which ability to write was not lost. The chronic cases of this kind that I have seen have been mostly cases of pretended loss of speech. Besides, how is it conceivable that a person who has lost *speech* should be able, to express himself in writing? If a person can express himself in writing, he gives proof that he has *not* lost speech. We must speak internally before we write—before we express ourselves in writing.

*part* of thought—a part which we may or may not exteriorize. Again, it is not well to say that thought is internal speech, for the man who is speechless (the man who has no internal speech) can think. How well or ill he can think we shall discuss later. His condition results from a unilateral lesion; his left hemisphere is damaged, but his right is healthy, and in that hemisphere there still, I suppose, lie processes for words.

There are two ways in which words serve in thought; speech is but one way, and this, whether it be internal or external, is, speaking physiologically, a function of the left cerebral hemisphere.

Those who do not limit the definition of speech as we have done, would suppose that if a man had lost *speech* altogether (internal as well as external) there could be nothing further to say about *words* in his case; for it is sometimes assumed that words serve *only* in speech. But the cases of persons who have lost speech show, I consider, that speechlessness does not imply wordlessness<sup>1</sup>; for if I say to a man who cannot speak at all, "Gold is yellow" (or anything not difficult<sup>2</sup> or novel to him), he readily understands it. This shows that he still has processes for words in his brain. His "ideas" of gold and yellow are only to be reached through words. If he had not processes for words *in himself*, how could he possibly understand my words? My words revive his words. If they did not, I might as well speak to him in a language he did not understand, or clap my hands.

To coin the word "verbalizing," to include all ways in which words serve, I would assert that both halves of the brain are alike, in that each serves in *verbalizing*. That the left does is evident, because damage of it makes a man speechless. That the right does may be inferred, because the speechless man understands all I say to him on ordinary matters. And yet since the patient cannot repeat after me, even in writing, the proposition he so readily understands (since he can only receive it and cannot give it out), it follows that the word processes which remain in his right undamaged hemisphere are not of the same kind as those by

<sup>1</sup> I ought to mention, however, that it has been said that cases of loss of *speech* give proof that thought is possible without words; it being tacitly assumed that the speechless patient is wordless. The speechless man can think, I suppose, because he has in automatic forms all the words he ever had; he will be lame in his thinking, because, not being able to revive words (to speak to himself), he will not be able to register new and complex experiences of things.

<sup>2</sup> In order that a healthy person may *understand* anything very novel or difficult, speech is evidently required—mostly internal, but it may be external. If a person be told anything complex, we may hear him telling it again to himself. This, I suppose, the speechless patient cannot do; but to superficial observation he understands everything. He understands tales read to him, and remembers their incidents.

which speech results. In other terms, word processes are not of the same kind in each half of the brain.

Let us consider the two different ways in which, as I suppose, words serve in the two halves of the brain. I illustrate by propositionizing and receiving propositions. To receive a proposition and to form one are plainly two very different things. It is true that in *each* case *our own* nervous centres for words are concerned; but when we *receive* a proposition the process is entirely automatic, and unless we are deaf, or what is for the time equivalent, absorbed, we cannot help receiving it. When anyone says to me "Gold is yellow," I am, so to speak, his victim, and the words he utters rouse similar ones in me; there is no effort on my part; the revival occurs in spite of me if my ears be healthy. Moreover, the speaker makes me a double gift; he not only revives words in my brain, but he revives them in a particular order—he revives a proposition. But if I have to say, "Gold is yellow," I have to revive the words, and I have to put them in propositional order. The speechless man can receive propositions, but he cannot form them—cannot speak.

The left half of the brain is that by which we speak, for damage of it makes us speechless; the right is the half by which we receive propositions.<sup>1</sup>

But this is only an imperfect way of putting it. We, as anatomists and physiologists, have to do only with nervous processes for impressions and movements, and their conditions of energizing; and, as before said, we have to bear in mind that the essential thing is excitation of nervous processes. We have not to dwell with exaggeration on *actual* movements from strong excitations. I say movements advisedly.

We have, as anatomists and physiologists, to study not ideas, but the material substrata of ideas (anatomy) and the modes and conditions of energizing of these substrata (physiology). Where most would say that the speechless patient has lost the memory of words, I would say that he has lost the anatomical substrata of words.<sup>2</sup>

<sup>1</sup> For fear of misunderstanding, let me now remark, that although betwixt propositionizing and receiving a proposition there is the difference that in the former process there is usually actual utterance and in the latter usually only internal revival of words, this is not the most essential difference. The essential difference is not that betwixt the internal and external use of words, for speech may be internal; we can, and constantly are speaking to ourselves. The difference is in, or corresponds to, the voluntary and automatic use of words.

<sup>2</sup> Psychology is the elder science; mental operations were studied before the brain was known to be the organ of mind. Hence, however much we may wish to study the anatomy and physiology of the higher parts of the nervous system without psychological bias, we are obliged, for lack of others, to use words which have psychological implications. The words "voluntary" and "automatic" are such words, but they are also used physiologically.

The anatomical substratum of a word is a nervous process of a highly special movement of the articulatory series. That we may have an "idea" of the word, it suffices that the nervous process for it energizes; it is not necessary that it energizes so strongly that currents reach the articulatory muscles. How it is that from any degree of energizing of any kind of arrangement of any sort of matter we have "ideas" of any kind is not a point we are here concerned with. Ours is not a psychological inquiry. It is a physiological investigation, and our method must be physiological. We have no direct concern with "ideas," but with more or less complex processes for impressions and movements.

When *movements* of words are spoken of, it is not necessarily meant that *actual* movement of the articulatory muscles occurs. As already mentioned, there is in the left hemisphere during internal speech simply a slight excitation of the *highest* of the nervous processes of the articulatory series, which are strongly excited when words are actually uttered. Similarly, in the automatic revival of movements for words in the right side of the brain (as, for example, in receiving speech of others), there is supposed to be a slight excitation. These may be spoken of as nascent movements, or "ideal" movements. Saying nothing of dreaming that we are speaking, of dreaming of objects and of the internal sight of the blind, there is plenty of positive proof from morbid conditions that central excitations give us ideas of movements when there are no actual movements. The most striking is the production of movements, necessarily ideal, of an absent hand by faradizing the stump. The excitations in this case must be central, awakened by a stimulus of the sensory nerves roused into activity by faradism. The excitation of sensori-motor processes for words, even in the right cerebral hemisphere, may be so strong that these words are occasionally actually uttered. Thus, a speechless patient whose left hemisphere is damaged may occasionally swear when vexed. We now, therefore, classify the movements of verbalizing physiologically into voluntary and automatic, which classification corresponds to propositionizing and to receiving propositions. So now I say the right half of the brain is for the automatic reproduction of *movements* of words, and the left the side for their voluntary reproduction.

But here we must mention that this distinction is not absolute; there are nowhere in the body absolute demarcations betwixt voluntary and automatic movements; and there are in health all gradations from the most automatic use of words to their most voluntary use. Let us show some of the steps: (1) Receiving a proposition. (2) Simple and

compound interjections, as "Oh!" and "God bless my life!" (3) Well-organized conventional phrases, as "Good-bye," "Not at all," "Very well." (4) Statements requiring careful, and, metaphorically speaking, personal supervision of the relation each word of a proposition bears to the rest. We now amend the former statement, and say that the right is the automatic side for words and the left the side where automatic use of words *merges into voluntary use of words* (speech). In healthy persons, I suppose there is automatic revival of words prior to their voluntary revival (speech).