

VII. APHASIA AND AGRAPHIA.

THE object of this paper.—That the cerebral hemispheres are the organ of intelligence is universally admitted. But whether they are to be looked on as a single organ, one and indivisible, or rather as a congeries of distinct organs, in each one of which a distinct faculty of the mind is lodged, is a question which since the days of Gall has divided physiologists. The majority incline to the latter view—that of the localisation of mental faculties—in varying degrees. But it must be admitted, that though the arguments they adduce give great probability to their view, yet they are far from being actually conclusive.

It would clearly be a great step gained, could any one undoubted instance of cerebral localisation be made out; any one case in which a special mental faculty and a distinct portion of a hemisphere were so inseparably bound up together, that the integrity of the one absolutely implied the integrity of the other. An attempt has been made lately, chiefly by French physiologists, to establish such an instance. It is said that the faculty of articulate speech is inseparably connected with a certain limited portion of the left hemisphere, this portion being the posterior part of the inferior or third frontal convolution.

The chief object of this paper is to examine how far the pathological records of our hospitals harmonise with this doctrine. But at the same time I shall give a general sketch of the subject for the sake of those who have not yet turned their attention to the matter.

History of the question.—Gall, as is well known, located the faculty of language in that part of the anterior lobes which lies above the orbital plates, and professed to find in prominence of the eyeballs the external indication of a pre-eminence in this respect.

In 1825 M. Bouillaud published his *Traité de l'Encéphalite*. Like Gall, he located the faculty of speech in the anterior lobes, but did not, as Gall had done, fix on any limited portion of these lobes. "Tout ce que mes propres observations m'ont appris jusqu'ici relativement à la localisation des organes cérébraux intellectuels ou à la détermination du siège de ces organes, c'est que les lobules antérieures du cerveau sont les organes de la formation et de la mémoire des mots ou des principaux signes représentatifs de nos idées." And he asserts that "la perte de la parole et de la mémoire des mots est la conséquence inévitable d'une désorganisation de la partie antérieure du cerveau" (p. 285). The next step was made by M. Dax of Montpellier. In a paper read there in 1836,* M. Dax stated that it was the left hemisphere only that was concerned in speech; that the faculty which Gall and Bouillaud had lodged indifferently in either anterior lobe was in reality located only in the left one; and that consequently when loss of speech and paralysis were associated, the paralysis was invariably on the right side of the body. At a later period the son of this M. Dax not only repeated his father's statement, but with greater precision limited the seat of the faculty to that portion of the left hemisphere which borders on the fissure of Sylvius.

M. Dax's paper seems to have escaped the amount of attention which its importance deserved, and the whole question to have been left at rest for many years. It was not till 1861 that it again came to the surface.† In that year a most interesting discussion took place at the Anthropological Society of Paris on the whole subject of cerebral localisation; M. Gratiolet being the chief supporter of the "unity of the brain" theory, MM. Broca and Auburtin his chief opponents. In consequence of this discussion M. Broca was led to pay attention to sundry cases of loss of speech which from time to time presented themselves to him; and the result of his observations was to confirm the statements of MM. Dax as to the left anterior lobe,‡ and with greater precision than

* This paper is reprinted in the *Gazette Hebdom.* 1865.

† Cf. *Bull. de la Soc. d'Anthrop.* ii. 1861.

‡ M. Broca arrived at his conclusion and published it before the result which M. Dax (fils) had reached independently appeared in print. Cf. *Gaz. Hebdom.* April 21st, 1865.

either of these gentlemen had arrived at to locate the faculty of speech in the posterior third of the inferior frontal convolution.*

Anatomy of the parts in question.—If a fresh brain be stripped of its membranes, and laid on its side so as to display a lateral surface, a furrow will be seen running from above the fissure of Sylvius almost in a transverse direction, but also slightly backwards, till it joins the great longitudinal fissure above. This furrow corresponds very nearly with the line of suture between the frontal† and parietal bones, and is known as the furrow of Rolando. This furrow forms the posterior boundary of the anterior lobe. All that part of the brain which is in front of it, and at the same time above the Sylvian fissure—all that part, therefore, which is covered by the frontal bone—is included in the anterior lobe. Behind the furrow, and covered by the parietal bone, is the parietal lobe; and again behind this, and separated from it by a slight furrow which exactly corresponds in position to the lambdoid suture, is the occipital lobe. There remain yet two other lobes—the temporosphenoidal, which is separated from the anterior by the fissure of Sylvius; and the insula, which lies hidden in the fissure, and is only brought into view when the anterior and the temporosphenoidal lobes are drawn apart and the depths of the fissure exposed. Of these five lobes the only one of which it is necessary to give any further account is the anterior. The convolutions on the surface of this may be arranged in two subdivisions—namely, the orbital and the frontal. The orbital are those which lie on the upper surface of the orbital plates, and are therefore best seen when the brain is placed upside down. The frontal are those which are visible when the brain is viewed laterally. These frontal convolutions are four in number, and are known under different names. First there is the posterior or transverse frontal: this forms the anterior margin of the fissure of Rolando. The three other convolutions run in a longitudinal direction, so that they meet the transverse one at

* The first to call attention to the matter in this country was Dr. Jackson. Cf. *London Hospital Reports*, 1864.

† The furrow of Rolando is slightly posterior to the coronal suture. Cf. *Bull. de la Soc. Anatomique*, 2d series, vi. 340.

more or less of a right angle. They are known as the first, second, and third, or as the upper, middle, and inferior frontal convolutions. These fundamental convolutions, themselves invariable, are divided by numerous secondary furrows into smaller folds; and these secondary furrows vary considerably in their abundance and in their direction in different individuals, and even in the same individual, when the two hemispheres are compared together. There is only one of them that has any great constancy. This runs in a longitudinal direction, and separates the upper or first frontal convolution into two secondary ones; and this so completely, that some anatomists consider them to be fundamentally distinct, and would therefore make four instead of three longitudinal frontal convolutions.* But this furrow, though constant in normal men, is absent in some idiots and in all inferior animals. It must therefore be considered a secondary and not a fundamental division. Of the second or middle frontal convolution there is nothing special to be said; and this brings us to the third or inferior one. This forms the upper boundary of the fissure of Sylvius, and is therefore sometimes spoken of as the "superior marginal" convolution. It is in this convolution and in its posterior third that Broca localises the faculty of articulate language. It will at once be seen that this statement, though more precise, does not differ much from that of M. Dax (fils), who places the faculty in the convolutions about the junction of the anterior and middle lobes. Both Dax and Broca, moreover, add the further limitation, that the seat of the faculty is on the left side only.

Means of investigation.—There are usually three ways of investigating such a question as this: direct experiment, anatomical research, pathological observation.

Direct experiment.—Of these, the first is clearly inapplicable in the present case. For man is the only animal that speaks, and on him we cannot experiment. Some, however, may think that the sounds made by animals bear a certain analogy to articulate speech, and may possibly be imperfect symbols by which animals communicate in some degree with each other. To such it may be interesting to know what is the result of injuring in animals the hinder portion of the

* Cf. Auburtin, *Soc. Anthropol.* 1861, p. 212.

anterior lobes. M. Bouillaud pierced with a gimlet the head of a living dog from side to side. The instrument passed through the brain at the junction of the anterior and middle lobes—that is, about the part which corresponds to Broca's region. After death it was found that there was a canal as big as one's finger in this part, and that all the rest of the brain was perfectly healthy. The dog recovered completely from this fearful operation, though with the loss of much of its former intelligence. The point, however, of chief interest is this: the dog entirely lost its power of barking. It could still make sounds, uttering sharp cries when in pain. But during the two months that it lived in perfect health after the operation it was never heard to bark, as it had been used to do, so as to express its emotions.* “Il n'aboyait point, soit pour témoigner son affection, soit pour éloigner les étrangers qui venaient à la maison.” To this experiment I do not, however, myself attach much importance, because of the absence of any certain analogy between the bark of a dog and the articulate speech of man. There is then little help to be got from experiment; and I pass on to the arguments from anatomy.

Anatomical arguments.—So little is really known of the minute structure of the cerebral hemispheres, that even here we get little assistance. Still two different arguments have been derived from anatomy, both unfavourable to Broca's opinion. One of these is directed against the unilateral localisation of the faculty, the other against localisation altogether.

The first. It is said that in an organ so symmetrical as the brain it is impossible to admit a difference of function between the two sides. One hemisphere exactly resembles the other in form, and must therefore as exactly resemble it in its office. This is the argument on which M. Trousseau relies, and it has been advanced also, among others, by Vulpian. “Il paraît absolument certain que les deux hémisphères cérébraux doivent avoir les mêmes fonctions, et que si les facultés sont localisées dans telles ou telles lésions, ils ne sont pas les uns dans le côté droit du cerveau, les autres dans le côté gauche; mais qu'elles doivent se trouver toutes

* Magendie's *Journ. de Physiol.* x. 89.

dans chacun des deux hémisphères et distribuées d'une façon symétrique."* But is there really such an absolute symmetry between the two sides of the brain as to justify this summary conclusion? Most certainly there is not. The secondary convolutions are never arranged in the same way in the two hemispheres. And it is a notable fact, that this want of symmetry is peculiar to man, or at any rate much more strongly marked in man than in any other animal. "In comparing," says Todd, "the human brain with that of the inferior animals, we notice great† exactness of symmetry between the convolutions of opposite hemispheres in the latter, and the want of it in the former. It cannot, however, be said that the convolutions of opposite hemispheres in the human brain are absolutely unsymmetrical. A careful examination will show that the same convolutions exist on each side, but apparently of different sizes, and not closely corresponding as regards situation."‡ It would thus appear that man, distinguished from other animals by his faculty of speech and by his higher intellectual capacity, is also distinguished from them by the want of symmetry in his two hemispheres. We may go even further than this. At that period of life when the intelligence is undeveloped, and the faculty of speech not yet acquired, the brain even in man presents perfect symmetry on its two sides. "In the imperfectly developed brains of the infant or young child" (I again quote from Todd) "the convolutions are quite symmetrical." Thus the development of the intelligence and the addition of speech is accompanied by a loss of symmetry in the hemispheres; and clearly if any conclusion at all is to be drawn from this, it must be in favour of, and not adverse to, the theory of unilateral localisation.

It may indeed be that originally the two sides are perfectly symmetrical, and that there is at that period a strict

* Vulpian, *Phys. du Syst. Nerv.* p. 717. So also Bouillaud, *Tr. de l'Encéphal.* p. 263.

† It is too strong a statement to say that there is a perfect symmetry in the brains of all other animals than man. This is true of most, but not of all inferior mammalia. The seal, for instance, has unsymmetrical hemispheres (see *Leuret et Gratiolet*, pl. xi.); and so have the higher apes, but in a less degree than man.

‡ Cf. *Cyclop. of Anat. and Physiol.* iii, 697.

similarity in form and properties between any two corresponding parts. In this case we may suppose with Dr. Moxon the difference between the two sides to arise in the course of education. The education of an organ is a laborious task, and not the easiest is that of the organ of language. In order to spare ourselves trouble, it may be that we limit our task to the instruction of one organ, instead of two; the necessary duty being as well performed by one side as by both, so long as the brain is healthy. And this view would explain several difficulties. It would, for instance, explain the few exceptional cases to which I shall have to recur later, in which loss of speech has depended upon disease of the right side of the brain, not of the left. We may suppose that in such cases, from some unknown cause or other, the educational development has selected the right side instead of the corresponding part on the left, just as in some more frequent cases we see the left hand educated to perform duties which in the vast majority of men are only performed by the right. It would explain, moreover, the fact that the faculty of speech is seldom entirely lost. Almost invariably, even in the most striking cases, there remains the power of giving utterance to some few words. This residue of power may be due to some feeble degree of education shared in by the right side of the brain. Again, this view would explain the gradual improvement of speech which occurs in some patients after they have been long almost entirely unable to articulate. In such cases it is of course possible that the lesion on the left side has been repaired; but it is also possible that the improvement may be due to a gradual education of the corresponding organ on the right side.*

The second. A second argument has been derived from anatomy, not against unilateral localisation, but against localisation altogether. It is urged that the minute structure of the several convolutions is identically the same; that there is no difference to be detected in the elements of which they are composed, nor in the way in which these elements are combined. Such perfect identity of structure, it is said, involves identity of function. Now, in answer to this, it might

* See additional note on this point, at the end of the paper.

be replied that our knowledge of the minute structure of these parts is so imperfect as to render such an argument really worthless. Secondly, it might be said that very great differences in function are perfectly consistent with apparent similarity of structure. What microscopist can distinguish a secreting cell taken from a lacrymal gland from one derived from the pancreas? Yet under this apparent similarity lies hid some unknown difference which causes them to act in entirely different ways. Such a difference, for all we know, may exist between the nerve-cells of separate portions of the hemispheres. But, lastly, there is a still more satisfactory reply. The supposed uniformity of structure does not exist. This has been clearly established* by Broca in the case of some convolutions, and he thinks he has discovered it in the case of others. He believes, in fact, that each principal group of convolutions presents certain distinguishing characteristics in the arrangement of its gray matter. Thus the cortical layer is much thinner in the lobe of the *insula* than it is either in the frontal or in the occipital region; and a still more curious distinction exists between the convolutions of the two latter.

If a thin slice be cut, at right angles to the surface, from one of the frontal convolutions, or in fact from any excepting the inferior occipital convolutions, and then gently pressed between two pieces of glass so as to spread it out without actually crushing it—if such a section, I say, be made and held up against the light, the following appearance will be recognised. It will be seen, as Baillanger first pointed out, that the so-called gray layer is formed of six distinct laminae, which are alternately opaque and semi-transparent, the opaque laminae consisting of white matter, the transparent ones of gray. The most superficial of the six is opaque (*Bull. de la Société Anat.* xiii. 302), then comes a gray layer, and so on alternately to the sixth, which is gray and continuous with the medullary substance of the convolution.

But if a similar slice be taken from one of the inferior occipital convolutions and examined in the same way, instead of six layers only five will be found. It would seem that this is due to the absence of the second layer of gray matter; for

* *Bulletins de la Soc. Anat.* 1861, p. 318.

the second opaque lamina is much thicker than the rest, as though it had become confounded with the third by the absence of the intervening transparent portion.

What the import of this special arrangement may be is quite unknown. Some doubtless it has, for the arrangement is constant. For the present purpose it is sufficient to point out that the structure of different convolutions is different, and that difference in structure naturally suggests difference of function.

The argument from pathology.—From what has preceded it is, I think, plain that neither experiment nor anatomy furnish grounds for rejecting at once the view upheld by Dax and Broca. I pass on to the evidence furnished by pathology. This is of all the most important. For it was from pathological observations that the theory was first derived, and it is by this that a certain solution of the question will doubtless in time be furnished. It is stated by Broca, or those who agree with him, that the portion of the brain in question has never yet been found in a state of disease without impairment of the faculty of articulate speech, or, as it is now termed, without “aphasia;” and that a like statement cannot be made of any other portion of the convolutions. Secondly, it is also stated that true aphasia never occurs unless either this part be itself diseased or those portions of white matter by which it is connected with the parts below. The former of these two propositions is, I believe, uncontradicted. There is no case, to the best of my knowledge, on record in which disease of the posterior part of the third frontal convolution on the left side has co-existed with integrity of speech. Still it is not impossible that such a case should arise. Such an exception would be no sufficient refutation of the theory. For, as I have already noticed, there is good reason to believe that in some few individuals it is on the right and not on the left side of the brain that the central organ of speech is situated. No single case, therefore, would be a perfect refutation of this first proposition, excepting one in which there was a lesion both on the right and the left side.

The second proposition is more open to question, and less easy to deal with, for this reason. We do not know with precision how the fibres run which connect any given portion of

the convolutions with the organs below. We cannot, therefore, say with certainty what lesion of the white matter would isolate such a portion, cutting off its communications downwards. Still, when we see cases of aphasia in which the convolutions are sound, but there is a larger destruction of the white substance in the left hemisphere, or even a more limited one in the near neighbourhood of the supposed organ of speech, then, if the first proposition be admitted, it is a fair interpretation to say that the aphasia is produced by the isolation of that organ; such isolation being, of course, practically equivalent to destruction.

It must, however, be admitted that there are on record a certain number of cases—not very numerous—in which speech was notably impaired, and yet after death no lesion was found either in the third frontal convolution or in the white matter near it, but some damage or other in distant portions of the brain. These cases, of course, present a difficulty; but there are some considerations which tend, I think, very much to lessen it. In the first place, these cases are almost all recorded by persons who were in ignorance of the theory we are discussing, and who therefore had not their attention specially called to the condition of this portion of the hemisphere. Now there is nothing so easy as to pass unnoticed a limited lesion of the gray matter of the convolutions. In the most typical case of aphasia (case v.) I have seen, there was a lesion very limited in extent, though very thorough in degree, in the exact spot fixed on by Broca. This lesion would certainly have escaped notice, had it not been specially looked for. The brain when removed from the skull looked healthy on its surface. It was only on removing the pia mater that the almost diffuent condition of the limited spot was discovered. It is not the rule in post-mortem examinations to remove the pia mater. Such a lesion, then, would only be discovered by accident in an ordinary examination; and the chances of hitting on it would be still less if the attention was directed to some more manifest injury existing in some other portion of the brain, such lesion being supposed sufficient to account for the symptoms observed in life. That such is the explanation of many, at any rate, of these apparent exceptions can, I think, scarcely be doubted,

when we consider that almost all occurred before attention was specially directed to the matter. Another consideration which may explain some of their apparent exceptions is this: not every impairment of articulation is aphasia. What true aphasia is I shall have soon to consider. At present it is enough to say that it is limited to loss of speech from certain mental impediments, and does not include the speechlessness which is produced by paralysis of muscles or disarrangement of the external organs of articulation. Now it is very possible that in some of the apparent exceptions the difficulty of utterance depended on these latter conditions, not on the former. Again, in some of the cases supposed to contradict Broca's theory, not only has the third frontal convolution been apparently free from disease, but no lesion has been found in any part of the brain whatever. The whole organ has seemed healthy. If these cases are admitted as evidence against Broca's doctrine, they must equally be admitted as evidence against the doctrine that the brain as a whole is the organ of intelligence. This no one will admit. What they really prove is, that there are lesions of the brain which escape our present accuracy of research; minute yet all-important alterations in the structure of nervous centres which we are as yet perfectly unable to detect. We must clearly first find out what these alterations are before we can say that they did not exist in any given case in the third frontal convolution.

Aphasia.—I said just now that every impairment of articulation does not constitute true aphasia. It is necessary, therefore, to consider to what condition of speech this term is applied.

Man communicates with his fellows by means of certain conventional symbols of various kinds, and addressed to various senses. Of these symbols the two of greatest importance, and the only ones which concern us now, are those used in speaking and in writing. And first of speech.

What is necessary in order that a man shall understand the spoken symbols of another? First, he must have a certain external organ, the ear, to receive the impressions of sound. This ear, again, must be connected by a nerve with a certain

central organ or ganglion, to which the impressions may be conducted, and in which they may be converted into sensations. Thirdly, this central organ must be connected with the cerebral hemispheres, and the connecting links must have been so modified by habit that each distinct sensation in the ganglion shall call up in the hemispheres a distinct idea. Now in aphasia all these processes remain without injury. The patient hears and understands all that is said to him as well as if in perfect health. There is no diminution in his power of interpreting symbols, of converting them into ideas.

What is necessary in order that a man shall communicate his ideas to another by speech? In the first place his ideas must evoke at once their appropriate symbols in his mind, each idea mentally clothing itself in the word or words which conventionally stand for it. This faculty of converting ideas into symbols is quite distinct from that of converting symbols into ideas. The one may be acquired or lost independently of the other. Thus, a child learns to interpret the language of others before it can itself speak. Adults as a rule follow the same order in learning a foreign language. Most of us moreover know what it is to have the pictorial image of some familiar object in our mind, and yet to be perfectly unable to call up its name. The idea is there, but the idea does not suggest the proper symbol. The moment, however, some other person uses the word in our presence it is at once perfectly recognised. Now a similar forgetfulness of words, but more extensive—a similar inability, that is, to translate ideas into symbols—constitutes one form of aphasia; a form which I will call *Amnemonic Aphasia*, to distinguish it from another variety to be mentioned presently. The patient in such a case suddenly in speaking stops short, unable to recall the word he requires. The moment, however, that he is prompted he is able to go on. If the faculty is much impaired, and the stoppages consequently very frequent, the patient becomes more and more taciturn, yielding in despair to the increasing difficulty. Sometimes, instead of actually stopping in his speech, he avoids the difficulty by some periphrasis, or frequently substitutes for the forgotten symbol some perfectly different one, with a perfectly different meaning. He will say, for instance, “two-shilling piece” when he means to say

“spectacles” (cf. case iii. p. 104); and it is noticeable that often though the two words, that used and that meant, are utterly unlike, yet that there is a certain degree of similarity in the pictorial images of the objects for which they stand. Thus a patient may say “boat” when he wishes to say “tub;” and perhaps the substitution was of the same kind in the instance I just gave. When the man said “two-shilling piece” instead of “spectacles,” there was probably some confused notion of duality and circular shape which led to the exchange. More frequently, however, the resemblance is one of sound, not of image. The defect here is a slighter one. The symbol is only half forgotten, not entirely. Thus “purging” will take the place* of “perjury,” “pamphlet” of “camphor,” “dispersion” of “dispensary,” and so on. But in many cases no connecting link either of image or of sound can be detected. Thus “wagons” replaced “dresses,” “winkles” replaced “watercresses” in case iii. In all cases, however, it appears to be a constant fact that grammatical form is observed; only substantives are substituted for substantives, verbs for verbs, numerals for numerals, proper names for proper names. I have neither seen nor read any case in which there was an exception to this rule.

The first requisite, then, for the expression of ideas in speech is the memory of words; and the loss or impairment of this faculty constitutes amnemonic aphasia. But besides this a second act of memory is required, closely connected with the former, yet distinct from it. Not only must we remember words, but we must also remember *how to say them*. The utterance of each word is a complex action, requiring the coördinate uses of many muscles. The power of performing it we acquire gradually by conscious effort; and though when once acquired it becomes so easy as to seem to be quite independent of mental aid, yet in reality it is not absolutely automatic. It still demands a certain amount of attention for its due performance; and if this attention is withheld, our utterance becomes slovenly and indistinct.

Now the mere memory of words by itself may produce an inward repetition or mental rehearsal of a phrase, but it can do no more. For the utterance of the phrase in articulate

* Watson, i. 529.

sound, this second memory is absolutely requisite. Should it fail, we have a second form of aphasia, which for distinction we may call *Atactic Aphasia*, the loss of speech being due to the want of coördinating power over the muscles of articulation.

This second form of aphasia is distinguished from the former or amnemonic variety by this characteristic symptom. Prompting is no longer of the slightest help to the patient. You may repeat the word or phrase which he requires as often as you please before him, and he will remain as silent as before. For what he wants is not the word, but the recollection of the process by which to give it utterance.

Patients who suffer from this affection sometimes are entirely without speech. More frequently, however, they retain the power of saying some few words, and these generally are words of familiar use. Thus in case i. the patient could say "no;" this was his whole vocabulary. In case viii. the patient could only say "yes." In case xx. the vocabulary consisted of the two words "our father." In case ix. of the words "no," "yes," "bible." Sometimes the patient uses his limited supply of words correctly, and when the answer to a question requires other words, of which he is not master, remains silent or tries to supply the defect by pantomimic signs. In other cases he answers all questions alike with the same word or phrase, as though he were a parrot that had only learnt one expression. Thus the woman in case xxii. invariably said "yes" to all questions, whether a negative or affirmative was required. In some of these cases the patient seems unconscious of or indifferent to the impropriety of the answer; but in others he is clearly perfectly aware of it, and shows by his impatient gestures his distress when he has answered incorrectly.

In these cases of atactic aphasia it is of course impossible to say whether there is or is not amnemonic aphasia as well; whether or not there is, in addition to the inability to articulate, also forgetfulness of words. That the two forms do sometimes coexist is, however, plain from cases ii. and iii. Both these men were at first clearly affected with atactic aphasia. They were unable to speak even when prompted. But after a time the ataxia disappeared, and as they recovered their

power of utterance, it was found that they suffered from a considerable forgetfulness of words. It can hardly be doubted that this had existed previously in the earlier stages of the attack. In these men, then, there was not only deficiency of utterance, but also imperfect mental rehearsal of phrases.

On the other hand, it seems equally plain that atactic aphasia is not always accompanied by amnesia, or, at any rate, that sometimes if this latter defect be present at all, it is so in a far less degree than the ataxia. Otherwise patients who are utterly unable to articulate would be also utterly incapable of thinking. For thought without the mental rehearsal of words is impossible. But no one who has watched such a man as the patient in case v. would admit that all thought was suspended in his brain, or in a degree corresponding to his want of utterance. The expression of his face was lively and intelligent: he took a manifest interest in all that was going on about him, smiling when anything was said or done that tickled his fancy, and expressing himself by means of suitable pantomime. There is also on record a striking case in which a medical and scientific man, a well-known French professor, lost for a time all power of utterance, but afterwards recovered. He described how during his attack of aphasia he was able to arrange his lectures in his mind, and to marshal his facts and sentences in due order. It is impossible that he could have done this without the memory of words, yet his deficiency of utterance was complete. His malady, then, was purely atactic, with little or no mixture of amnesia.

The aphasia of Broca, as his cases show, is the atactic variety. The mental faculty, then, which he locates in the third frontal convolution, must be that which is required in the process of coördination. As the memory of words may remain when this faculty is gone, we are led to suppose that it must have a separate cerebral centre; but, at the same time, as the two faculties are so often coincidentally impaired, we may infer that the two centres are closely contiguous, so as to be easily involved in the same lesion. At present there are no precise observations as to the limits and relative positions of these centres. It is necessary, therefore, to deal with them as though they were one, and to give to this compound centre

some name which will serve to include both faculties. Such a name is "the central organ of articulate speech." Even this name, however, is not sufficiently wide. For, as will be presently seen, in this same region, and as yet without known lines of demarcation, are lodged other mental faculties, those, namely, concerned in the expression of ideas by written symbols. There are, moreover, on record a few cases, though I have never myself seen one, which countenance the notion that here too are portions of gray matter, the integrity of which is necessary for pantomimic expression. So that this portion of the brain would be the "central organ of language," meaning by language the expression of ideas in symbols of any kind, audible or visible.

The view, then, according to this, which would be most consistent with pathological observation is the following: that in this region of the brain are lodged the various mental faculties concerned in the expression of ideas by symbols; that each of these faculties has its separate centre, capable of separate lesion; but that the centres lie in such close juxtaposition that a single lesion is likely to injure several or all of them, in varying degrees.

There remains a third requisite condition for the expression of ideas in articulate speech. Not only must we remember words and how to utter them, but the external organs of voice and articulation, with their various muscles and nerves, must be in an adequate condition of health. Were these entirely paralysed, for instance, there could be no speech; but such a case would not be one of aphasia. For this term is, as I said before, limited to loss of speech from mental causes. It must, however, be remarked that in most, though not all, cases of true aphasia there is hemiplegia, and in this paralysis one side of the mouth and tongue are frequently involved in a slight degree. It might therefore be thought that the loss or impairment of speech was due merely to this partial paralysis, and had nothing to do with loss of memory or other mental defect. Such an explanation is, however, quite inadmissible. Paralysis of one side of the tongue and mouth interferes very little with articulation.* The most that it can do is to render

* It must, however, be admitted that in aphasia the tongue is often more affected than in simple hemiplegia. There is an inability to protrude

the speech somewhat indistinct and thick, but never to such a degree as to make it unintelligible. This 'thickness' of speech is quite distinct from and cannot be confounded with the total inability to pronounce words which characterises atactic aphasia, and still less with the tendency to substitute one word for another and the forgetfulness of terms which marks amnesia. No amount of paralysis, of course, can account for a man saying "two-shilling piece" when he means "spectacles," nor can it really account any more for a patient being unable to say any other words than "bible," "our father," "yes," "no," while he is able to utter these distinctly. It is just possible, indeed, as Dr. Jackson* has remarked, that a mistake might be made, when the tongue was paralysed totally on both sides, and the inability to speak consequent on this paralysis be erroneously called aphasia; but such complete lingual paralysis on both sides is excessively rare, and in the cases given in this paper does not occur.

Agraphia.—All that has been now said of speech may be said equally well of the expression of ideas in written symbols or writing, with, of course, the necessary substitution of 'eye' for 'ear,' 'hand' for 'mouth' and 'tongue,' and so on. Here too we meet in practice with cases in which the mental faculties concerned are impaired or lost. Of this defect, for which, for convenience, I would coin the name *agraphia*, there are moreover, as of aphasia, two forms—an amnesic and an atactic.

In amnesic agraphia the patient can form letters and words with sufficient distinctness, but he either substitutes one word for another, or, as in case ii., writes a confused series of letters which have apparently no connection with the words intended.

In atactic agraphia the power of writing even separate letters is lost, sometimes entirely, as in case iii. Here all attempts to write resulted in a mere succession of up and down strokes, bearing no kind of resemblance to letters. Sometimes, however, if the patient's hand be carefully watched while writing a given word, it will seem that there is a certain

it; whereas in simple hemiplegia the tongue can be protruded, though not in a straight line. So that it would seem that the loss of control over the movements of the tongue in atactic aphasia frequently includes other movements than those required in speech.

* Cf. *Lond. Hosp. Rep.* i. 398.

indistinct resemblance in the scrawls produced to the letters required; so indistinct and distant, however, as to render the whole illegible. I do not know whether the power of reproducing some one or two isolated words is ever retained, as is the case in atactic aphasia; but case i. would seem to imply that such may sometimes happen. The man in that instance was perfectly able to read written sentences, but he could not be got to write a single word or letter. He contrived, however, to write down the number of his regiment with sufficient distinctness for me to decipher it.

In the very few cases of atactic agraphia which I have myself examined with care, I have always found that besides the ataxia there was also amnesia. This I determined by the following method. I gave the patient a set of letters printed in large type, on separate pieces of card—such letters, in fact, as children use for playthings—and asked him to pick out and arrange the letters of his name. Had there been simple ataxia with unimpaired memory of symbols, he would have been able to manage this. But in no case have I found the patient able to do it; though he at once succeeded when his name was distinctly written down and set before him as a copy.

Aphasia and agraphia are usually combined together. As a rule, when a patient loses the faculty of speech, he at the same time loses that of writing. But this is not always the case. The man in case v. retained the power of writing, while his speech was limited to a few monosyllables. So in case iii. the man suffered both from aphasia and agraphia, but in very different degrees. The aphasia was slight and of the amnesic form; the agraphia was complete, and atactic as well as amnesic.

The occasional separation of agraphia and aphasia points, as I have already remarked, to the existence of distinct cerebral centres for the faculties concerned in speaking and in writing; while the more frequent coincidence of the two affections leads us to infer that these distinct centres must be closely contiguous.

CASES.

Of the following cases only the first five are from my own observation and notes. The rest I have collected from

our hospital registers. I have made no selection, but have given all cases I could find in our records,* in which loss or great impairment of speech formed a notable symptom. Many of these cases, it should be stated, have already been published. One (case v.) was brought by myself before the Pathological Society. Others have been published in various places by Dr. B. Jones, Dr. John Ogle, and Dr. Dickinson, not as illustrating aphasia, but as instances of various pathological alterations of the brain.

CASE I.—David P., a Chelsea pensioner; admitted Feb. 1867. Right hemiplegia and total loss of speech. Quite unable to give any account of himself. I learnt afterwards that he had been in this state since the preceding summer.

He could walk about, the leg being only slightly affected, and its sensibility good. The right arm was flexed and rigid, and the hand stiffly clenched. The sensibility in this limb was greatly impaired; at first I thought he could not feel at all, but I afterwards found that when his arm was pinched sharply and continuously, after a time he began to feel it. There was, however, no less an interval than thirty-five seconds between the moment when he was pinched and the moment when he showed signs of feeling. I tried this experiment many times, and always with the same result; the exact number of seconds, however, somewhat varying. When sensation was excited he recognised the exact spot pinched.

He could not protrude his tongue, though he could move it freely inside his mouth, and swallowed without difficulty. The right facial muscles were slightly paralysed; the pupils and eyes unaffected.

The only word he could say was "no." This word he used correctly, and when an affirmative answer was required nodded. He clearly understood what was said to him, and made useless efforts to

* This statement is no longer quite true. Since writing it I have changed my plan, and cut out those cases in which the loss of speech depended on disease of the pons Varolii. My reasons were, first, that I wished to shorten my paper; and secondly, that I had not sufficient cases to be of much service. The cases, moreover, would have given a wrong impression. They were all cases of disease of the left half of the pons with paralysis of the right limbs. This would have appeared very consistent with the other cases. But on examining a large number of recorded cases of diseased pons, I find that, though loss of speech goes more frequently with disease of the left half than with disease of the right, yet that this latter association is by no means uncommon. This would at first seem inconsistent with Dax's views; but I believe the explanation will be found to be this: that the nerve-fibres which pass down from Broca's region cross over to the opposite side during their passage through the pons; so that they may be equally injured by a lesion on the left in the anterior portion, or by a lesion on the right in the posterior part of the pons.

reply. He could read; for when a written sentence was placed before him, and he was asked to pick out any word in it, he always did so with perfect readiness.

He could write, as I learned from his sergeant, before his illness, but now could not form a single letter even when a copy was set before him. The only intelligible writing he could produce was the number of his regiment, 74. This he wrote so that I could read it, and I found afterwards that it was correct.

I gave him a set of largely-printed letters, and asked him to pick out his name. He managed after a long time to pick out the first two letters, but could get no farther. He then went to his bed, took down his card on which was his name, set it in front of him, and with this to help him picked out the rest.

There was no heart-disease. He remained in hospital without change for two months.

In this, as in most, though not all, cases of aphasia the patient could not protrude his tongue. Whereas, however, this symptom usually passes off in a short time, here it remained permanently. The speechlessness, however, cannot be attributed to this. For the tongue could be moved about freely in the mouth, and the loss of speech was much more complete than could be accounted for by any partial paralysis of that organ. Moreover, the man could utter distinctly the word "no," which requires the help of the tongue as much or more than the word "yes," which he was totally unable to pronounce. Lastly, the coincidence of agraphia shows this to have been a real case of aphasia. The peculiarity in the sensibility of the arm is worth noticing. Cases in which even a longer interval was required for the conduction of impressions to the sensorium are recorded by Lockhart Clarke in the last volume of these Reports, p. 77; and another, by M. Potain: cf. *Bull. de la Soc. Anatom.* 1861, p. 565.

CASE II.—Edward Thomas Dodswell, aged 34, on Dec. 3, 1866, after a drinking-bout, had several fits, and was found by his wife speechless. The next day another fit, which left him hemiplegic on the right side, and he was brought into hospital.

Dec. 7. Complete lax palsy of right arm and leg; incomplete paralysis of right side of face. Sensibility unaffected. Cannot protrude his tongue, though he moves it freely about inside his mouth. Deglutition unaffected. No heart-disease.

He can say a few words. Answers with "yes" and "no" correctly. I asked him his name. He made an inarticulate noise. Is it John? No.—Is it William? No.—Is it Edward? Yes.—Is it Thomas? Yes.—

How old are you? Twenty-four.—Twenty-four? No.—Thirty-four? Yes.—Say thirty-four. Twenty-four.—Can you tell the time? (showing him a watch) Yes.—What is it? Three (it was really two). No, it is two. Three, after a struggle.—Can you write? Yes.—Write your name. With his left hand he wrote distinctly "Hensislerges," which had not the slightest resemblance in sound or look to his real name.—Is that your name? (after looking at it with a look of perplexity) No.—Is this your name? (writing it for him.) Yes.—I could not induce him to try and write from a copy.

Jan. 18, 1867. Has so far recovered from his paralysis as to walk about the ward, and can now protrude his tongue. His speech is very little better, nor does prompting help him. He can say his name sometimes, but not always, and can count up to twenty, missing out, however, here and there a numeral. His writing is much as before: he can form the letters perfectly, but writes a mere unmeaning succession of them. A set of letters was given him, but he could only pick out the letters of his name when a copy was set before him. His sense of smell is very much diminished. When a strong-smelling drug is placed under his nose, and he is asked if he can smell it, he says "no." He can, however, perceive the tickling sensation of ammonia. He left the hospital without further change. Some months later I saw him again. He was much improved. He could now at once pronounce any word which he heard uttered; but he frequently misused words, calling things by the wrong name and even miscalling his children. He had recovered the power of writing, using his left hand.

The aphasia was here at first atactic. The man could not pronounce certain words even when he was prompted. But at a later period the ataxia disappeared, and the case became one of simple amnemonic aphasia. There can, I think, be little doubt that the amnesia existed at the earlier stage, co-existing with the ataxia, but masked by it. The agraphia was purely amnemonic. He had not forgotten *how* to write, but *what* to write.

CASE III.*—James Simmonds, æt. 54; Feb. 1867. This man had a heavy blow on the left side of the head seven years ago, and never was the same man as before. He was, in fact, obliged to give up his work from that time. Some years back his wife noticed that there was something strange in his speech. He spoke without difficulty or hesitation, but miscalled things strangely. He remained, however, in his usual state of health for several months, when he had a fit one morning while dressing. This left him speechless and hemiplegic on the right side. For a fortnight he could not speak at all, though quite sensible. He could not say so much as "yes" and "no." From this he gradually recovered, but always as before miscalled things. He frequently called his children by the wrong name; would say "Peter"

* This case is the only one which was not in the hospital. The man is a patient of mine at the St. George's Dispensary.

for "James," for instance. A month ago he had a second fit, which left him with less power than before in his right side, but made little or no change in his speech. When this second fit occurred he was suffering, as he had often done, from a slight attack of gout in the hand.

There is now partial paralysis of the right side, which does not prevent him from walking. The facial muscles on that side are slightly affected as well as the limbs. His speech is very hesitating and imperfect. He often stops suddenly at a loss for a word; then frequently uses a wrong one. As examples, he substituted "barber" for "doctor," "two-shilling piece" for "spectacles," "winkles" for "watercresses," &c. He can, however, pronounce perfectly any word when he is prompted. He says that he generally knows when he has used a wrong word, but not always.

Before his illness he wrote a good hand (I saw specimens of it), and was above his lot in education. Now he cannot form a single letter. Even with a copy before him he makes only uncertain up and down strokes. I gave him some printed letters, and asked him to pick out his name. After a long time he arranged JICMNOS. Clearly he had some slight notion of the letters which composed his name. According to his wife, before his illness, he spelt well, and was very particular about the spelling of his own name, which is one admitting of many variations. When a copy was before him he quickly picked out and arranged the name correctly. He can read; but he says that reading makes him very giddy, and causes great pain in the head. His general understanding seems good, and up to the average of men in his class. The tongue protruded without difficulty. Deglutition perfect. Senses of sight, smell, hearing good. The urine very albuminous. No heart-disease. Still under observation.

Here, as in the last case, the aphasia is at first both atactic and amnemonic, but after a time the ataxia gives way, and there remains simple amnesia. The agraphia is atactic, for he cannot form a single letter even with a copy: it is also amnemonic, or he would be able to pick out the letters which form his name. There is, however, some feeble recollection of the symbol. It is remarkable that in this man the agraphia is more complete and more enduring than the aphasia, whereas the contrary is usually the case.

CASE IV.—James Pascoc, æt. 26. Had several fits three years ago. For two years after them was utterly unable to speak, and was paralysed on the right side. As well as can be gathered from him, there was also at first some affection of the left arm. There is now palsy of right arm and leg, with great rigidity of the arm, which is flexed. Hyperæsthesia of all the right side, face included. He cannot bear to have it touched. Tongue freely protruded, and moved with per-

fect ease in all directions. Deglutition perfect. He can say a few words distinctly, but mostly talks in an unintelligible gabble, in which here and there a word can be made out. He also hesitates very much, as though he was trying to recall words to his memory. He clearly understands all that is said to him, and seems cheerful and intelligent. He states that he could write well before his fits. I cannot persuade him to make an attempt to write with his left hand. From a set of letters he cannot pick out his name. After a long time he arranged JASPENOS, in which there is plainly some feeble notion of his name. Directly I wrote his name and placed it before him, he picked the right letters out, and arranged them duly.

He can read. Heart sounds distant: no murmur. Still under observation.

This case is valuable, as affording evidence that the inability to speak in atactic aphasia is not due to paralysis of the tongue. This man could move his tongue with perfect freedom in all directions.

CASE V.—Joel B. Oct. 18, 1866. Had rheumatic fever and endocarditis twenty-five years ago, but since that has had good health. While at work on Oct. 15 fell down suddenly without losing consciousness, and found that he was speechless, and hemiplegic on the right side.

On admission he was found to have extensive heart-disease, with the pulse characteristic of aortic regurgitation. There was complete lax palsy of the right arm and leg, with unimpaired sensibility. There was at first some difficulty in deglutition, and in protruding the tongue; but this latter symptom passed away in a few days. There was slight pain in the left side of the head.

His speech was limited to the two words "yes" and "no." These he used correctly. After he had been in the hospital some time, he recovered the power of saying some few words, chiefly monosyllables.

He could write with his left hand with sufficient distinctness words which he could not pronounce, when asked to do so. In his writing there was often a tendency to reduplication of letters. For instance, he wrote 'Testatament' for 'Testament.' But I cannot say whether this was more than the result of deficient education.

His mind seemed quite clear. He understood all that was said to him; took interest in all that was going on about him; listened to conversation with an animated lively look, laughing at any little joke, and expressing himself frequently by suitable pantomime. In December he was attacked by oedema of the lungs, and died on the 20th.

Post-mortem.—Œdematous lungs: extensive aortic and mitral disease.

Much semigelatinous fluid in subarachnoid space. Surface of brain healthy, excepting at one limited spot. This was the posterior part of the third frontal convolution on the left side. Here was a softened, almost diffuent, patch, about three-quarters of an inch in breadth,

reaching from the highest point of the third convolution backwards and downwards to the fissure of Sylvius. The softened patch was not actually the most posterior part of the convolution, for there was a narrow unsoftened strip between it and the transverse frontal convolution. On cutting into the brain a second small patch of softening was seen in the centre of the left hemisphere external to and rather above the corpus striatum, and extending towards the posterior termination of the fissure of Sylvius. All the rest of the brain was apparently healthy.

The left middle cerebral artery was free in its main trunk; but in one of its secondary branches at a bifurcation was a hard shotty bit of fibrine, completely obstructing the passage, so that when water was injected into the vessel it could not pass, though considerable force was used. There were also fibrinous blocks in the spleen.

This is the only case of aphasia in which I have had the good fortune myself to examine the brain, and it is a case strongly corroborative of Broca's view. The sequence of phenomena is evident. First, rheumatic fever, and disease of the valves of the heart; later on, formation of fibrinous clots on these, and consequent embolism of the splenic artery, and of a branch or branches of the left middle cerebral; lastly, softening of the parts of the brain dependent upon them for their nutriment, and notably of the third frontal convolution in its posterior part.

The evident intelligence of this man forbids us from supposing that there was any great forgetfulness of words. The aphasia, then, was purely atactic. The processes of thought went on in his brain, and his ideas clothed themselves mentally in words, but the faculty of utterance was lost almost entirely. This, moreover, was not due to any paralysis of the tongue, for after the first four days that organ could be moved about or protruded with perfect freedom.

It will have been noticed that the faculty of writing remained in its integrity. There are but few cases of aphasia on record in which this has happened. These cases are valuable because they afford proof that the faculty of speech and the faculty of writing are not subserved by one and the same portion of cerebral substance (cf. p. 100).

The softening in this case resulted from embolism of the middle cerebral artery. It was first pointed out by Dr. Kirkes, and it is now well known that embolism of this artery is more certainly followed by atrophic softening than is that of any

other division of the carotid, and that the cause of this is the deficiency of anastomotic branches connecting this artery with others of the circle of Willis. Dr. Jackson has published a large number of cases in which loss of speech and diseased heart co-existed, and, though he had no post-mortem examination to assist him, inferred with a high degree of probability that the connecting link between the two conditions was embolism of the artery in question. The case just given confirms this opinion, as also do the following seven cases.

CASE VI.—Edward S., æt. 34. Admitted December 21, 1859. Six months previously had received a heavy blow on the left temple, and his eye had remained partially closed ever since. Six weeks ago began to feel numbness in the legs, which had not, however, prevented him from working as a gardener till two days before admission. On Jan. 9 he had a sudden attack of giddiness, followed by delirium; and later by ptosis of the right eyelid and some indistinctness of speech. Still later he entirely lost the power of speech, making merely inarticulate sounds. The ptosis disappeared the day before his death, which occurred eight days after his entire loss of speech.

Post-mortem.—The arachnoid and pia mater matted to each other and to the surface of the brain in several places; this was apparently an ancient lesion. The vessels at the base of the brain were atheromatous, and there was some old lymph deposited about them. The left middle cerebral was completely obstructed by a plug of fibrine. Below the plug the artery was somewhat dilated, forming a kind of small aneurism. This was in the fissure of Sylvius, near the locus perforatus anticus. A little further outwards the cortical part of the hemisphere was much softened. This softening extended a very short distance, the medullary part being firm. The fornix was also much softened.

In this, as in the post-mortem accounts of all the succeeding cases, the various convolutions are not accurately distinguished from each other; but the description leaves very little doubt that here, as in the last case, the part diseased was the posterior portion of the inferior frontal convolution. The case is a very important one, because of the absence of paralysis, and the limitation of the lesion to a small portion of the gray substance.

CASE VII.—J. C., admitted for supposed typhoid fever. "No perseverance could get a word from him. He rolls his eyes quickly and uneasily from side to side; does not heed questions, and makes no attempt to put out the tongue." He died a few days after admission.

Post-mortem.—A small mass of fibrine filled without distending the left middle cerebral artery. It probably was not large enough entirely to stop the blood-current. In the right middle cerebral was a smaller obstruction of the same kind. There was no softening. In the heart were ragged fibrinous masses sticking here and there to the depressions in the walls of the ventricles, and it was concluded that the clots in the vessels were derived from these. The valves were all natural in the heart. *P.-M. book*, 1864, p. 233.

CASE VIII.—Nicholas C., æt. 36, admitted August 24th, 1864, with diseased heart. On September 2d he had a sudden attack of loss of consciousness, and on recovering from it was found to be almost speechless. The only words he could be got to utter were "can't" and "yes." Sometimes when bidden he would put out the tongue; sometimes say, "Can't." He soon, however, regained the power of saying a few words, and used them rationally; though mostly he answered all questions by "yes." There was a certain amount of paralysis of the right arm, and the mouth was slightly drawn to the left. He died rather suddenly on September 21st, having called out "nurse" some twenty minutes before his death.

Post-mortem.—Soft fibrinous vegetations on aortic valves. Fibrinous blocks in spleen and kidneys. A considerable block of fibrine distended the left middle cerebral artery about two inches from its origin. The plug was short—little longer than its width; it had been arrested at a bifurcation. On the upper surface of the left hemisphere were a few minute spots of extravasation; and on slicing the brain horizontally many circumscribed patches of yellow softening were seen in the white matter. These were of small size—generally smaller than a fourpenny piece; yellow in the centre and red at the edges. They were most abundant in the posterior part of the hemisphere.

CASE IX.—Emma L., æt. 17, admitted December 23d, 1864, with diseased heart. Ten days later became suddenly unconscious, and on coming round was found to be speechless. The only words of which she made use were "no" and "yes." A few days later she became hemiplegic on the right side. There was no difficulty in swallowing. On January 28th, she began to cry out, "The Bible, the Bible," with wearisome monotony, when disturbed or uneasy; and this expression, to which she attached no meaning that could be discovered, was constantly on her lips till near her death, which occurred on Feb. 12th.

Post-mortem.—Aortic valves very extensively diseased, and covered with long soft vegetations. Fibrinous blocks in spleen and right kidney. There was a block of fibrine at the bifurcation of the basilar artery, completely obstructing it; another at the origin of the left middle cerebral, of large size; others of smaller size in more remote branches. All these plugs were of decolorised fibrine. *Prep.* 182, S. viii.

The whole left cerebral hemisphere, except a small portion at each extremity, was softened, and was readily excavated by drops of water.

The gray matter on the surface was of a dull brown. The left corpus striatum was softer and yellower than that on the right.

CASE X.—Richard C., æt. 45, admitted October 30th, 1850, with hemiplegia on the right side. This had come on gradually, without any distinct fit preceding it. "He was quite conscious and intelligent, but quite unable to articulate distinctly. In trying to speak, he uttered sounds, but they were apparently no part of the words he wished to pronounce." He remained in the hospital till his death, February 1851. During this period he varied in his condition; and at one time partially recovered the use of his paralysed limbs, and was able to say a few words. After this there was a relapse into his former condition.

Post-mortem.—Blood-coagula of long standing were found obstructing the basilar artery, both posterior cerebral, and the right carotid. The obstruction in these was only partial, a channel of one-third of the natural calibre remaining in the right carotid.

In the left carotid the obstruction was much more complete. Thick coagula lining the inner membrane were found just at the entrance of the artery into its canal; and on tracing the vessels upwards these coagula increased in thickness; so much so, that at the cavernous sinus, and above this point, the vessel was all but blocked up, there being a canal left scarcely large enough to admit a small pig's bristle. These coagula extended into the commencement of the anterior and middle cerebral arteries.

Both hemispheres were remarkably vascular. This was the only morbid appearance in the right hemisphere; but the greater part of the left was softened, and in parts quite different.

There was fibrinous deposit of long standing on the mitral valve.

A full account of this case, by Dr. Bence Jones, will be found in *Path. Trans.* 1850-1, p. 40.

CASE XI.—Emma C., æt. 21, admitted December 24th, 1862. Had had some kind of apoplectic attack shortly before admission, as to which no definite history was obtainable.

She was paralysed on the right side both arm and leg, but not the face. The tongue was protruded without any difficulty, and in a straight line. Her expression was intelligent, but her speech was unintelligible; the words being clipped and running one into another. In this respect, however, she improved; so that on January 13th she was reported to "answer questions rationally, but often to miscall things." There was a loud systolic murmur. She died January 16th.

Post-mortem.—Disease of mitral valve, on the flaps of which were fibrinous vegetations. Fibrinous block in left kidney. Complete plugging by embolism of both middle cerebral arteries, and consequent extensive softening on both sides.

CASE XII.—George H., æt. 17, was admitted December 21st, 1864, with disease of heart and ulnar aneurism of the right arm. On January 10th he had a sudden attack, in which he lost consciousness. This

was not followed at once by paralysis ; but on the 20th he had a second attack, and the following note of his condition was taken on the 22d : "Conscious, but speechless ; looks about him with much of his usual expression ; opens the mouth at bidding without putting the tongue out ; groans in answer to questions, as though he would reply to them if he could. The right arm is completely lax, and appears quite palsied. Left angle of mouth very slightly drawn." The same night he died.

Post-mortem.—Old disease of mitral valve. Fibrinous soft vegetations on the flaps. Fibrinous blocks in spleen and right kidney.

The middle cerebral artery as it lay in the left Sylvian fissure was surrounded and embedded in an apoplectic clot. The *coagulum* was followed into the middle of the left hemisphere, where, between the base of the brain and the floor of the ventricle in the middle lobe, was an extravasation as large as a hen's egg. A small opening was discovered in the artery near the beginning of the effusion of blood ; but it appeared uncertain whether this had not been made artificially. At the origin of the right middle cerebral was a small mass of decolorised fibrine, which must have quite blocked up the mouth of the vessel.

In the subarachnoid cavity, opposite to the end of the left Sylvian fissure, was a little extravasated blood. The brain was generally firm.

The rupture of the left middle cerebral artery is equivalent to embolism of that vessel, so far as regards the nourishment of the parts to which its branches run. I have therefore classed this case with those in which an obstruction was found in the artery. These are all the cases of such obstruction which I can find in our records, excepting some few where the patient died from the effects of the first shock without recovering consciousness, and which are therefore useless for the present inquiry. We have then eight cases in which the part of the brain supplied by the left middle cerebral artery is cut off from its blood-supply ; and in all of these the faculty of speech is much impaired. In four of these cases, it is true there was more or less obstruction of the corresponding artery on the right ; but omitting these, there still remain four others in which the left vessel was alone affected. With these stands in striking contrast the only case I can find in our registers where there was embolism confined to the *right* middle cerebral. In that case (P.-M. book, 1860, p. 116) there was a clot completely obstructing the right artery from the carotid to the island of Reil, and extensive softening of the brain-substance thus deprived of its nourishment ; and yet the patient retained the faculty of speech in its integrity.

I now pass on to some cases in which the left middle cerebral was not itself obstructed, but the carotid, of which it is the chief intracranial branch. When either carotid is blocked up, whether by ligature or other impediment, as a rule no grave head-symptoms are produced, nor atrophic brain-softening, because of the free anastomosis provided by the circle of Willis. When, however, as sometimes happens, the anastomosis is not sufficient for the purpose, and softening does occur, those parts are most apt to suffer—as Dr. Todd pointed out—which are dependent on the middle cerebral branch. For this branch has a much less free communication with the opposite side than have the rest (cf. *Med.-Chirurg. Trans.* xxvii. 321). The three cases which follow may therefore really be considered as equivalent to cases of partial obstruction of the middle cerebral artery.

CASE XIII.—J. G., August 1864. Two days before this man's death his left common carotid was tied by Mr. Lee. In the interval between the operation and death he was speechless. "He lies in a semi-conscious state; evidently recognising people, but being unable to respond to questions."

There was no post-mortem examination of the head.

CASE XIV.—William S., æt. 60, admitted March 10th, 1860. Two days before this, while following his occupation as clerk, began to lose power in the right side without any definite fit. There was on admission complete lax palsy of the right leg, palsy with some rigidity of the right arm, little if any paralysis of the face. He appeared to understand what was said to him; but to be unable to find the words wherewith to reply. He used the same word several times, with long pauses between; the articulation being, however, clear. "How are you?" "Well—well—well." "Any pain?" "Flying about—flying about—flying about." On April 2d he had an epileptic fit and died.

Post-mortem.—The right hemisphere was perfectly healthy. On the left side all the upper part of the hemisphere was in a state of white softening, forming a pultaceous mass. The softening extended down nearly to the level of the ventricle, and affected the superficial portions of the optic thalamus and corpus striatum.

The arteries of the brain were extremely atheromatous; and it was noticed that the left carotid was far more affected than the right. Its walls were much thickened in places, and in others the artery was irregularly dilated. In one place, by the side of the clinoid process, the artery was closed by a coagulum. This, however, was red in colour, and not adherent to the side of the vessel.

CASE XV.—Thomas B., æt. 36. Had fallen down in a fit, and was brought, on July 4th, 1865, to the hospital. The following is the

registrar's account of his condition: "He obeys feebly; but is quite unable to speak or protrude his tongue. There is a rigid condition of the muscles of the left arm, without total palsy. He swallows ill; has a flushed or sunburnt face, and an expression of intelligence contrasting strangely with his inability to speak or otherwise respond to questions. There is no facial palsy." He lived only three days, and died without any notable change in the symptoms.

Post-mortem.—Long cord-like coagula were drawn out of both carotids from the base of the skull. These were not adherent, and uniformly black. Many arteries at the base were similarly occupied. The basilar and both exterior cerebral were thus affected. The vessels were atheromatous.

The brain was much congested; the gray matter dark, and the pia mater vascular. The valves of the heart were natural.^o

Had this man not died, his case might have been quoted as contradicting Broca; for it was the *left* arm which was rigid, the right side being unaffected. But the post-mortem examination showed that both sides of the brain were alike implicated. In the absence of any other lesions, we must attribute the symptoms to the formation during life of coagula in the diseased cerebral vessels. Death occurred so soon after the seizure that the coagula had not undergone any change.

I have now given eleven cases of aphasia in which there was obstruction of the cerebral vessels. So frequent is this coincidence, that a good observer has supposed that loss of speech is a symptom of general occurrence in cerebral embolism, in whatever artery the clot may be. But in reality the symptom only occurs when the obstructed artery is the left middle cerebral, or more rarely the left carotid.† The cases which follow show, moreover, that the symptom may occur without any embolism at all. All that is necessary is that certain parts of the brain to which the above-mentioned vessels go shall be diseased; and whether this disease be the result of embolism or of other causes is a matter of indifference (cf. *St. George's Hospital Reports*, i. 266).

CASE XVI.—Charles C., admitted April 25th, 1866, having fallen from a height and injured his head and back. There was incomplete paraplegia. "He was quite sensible, and evidently understood all that was said to him, but was unable to answer questions." The next day

* On referring to the account of the post-mortem examination in this case, I find that the coagula extended into both middle cerebral arteries, as well as into those mentioned in the text.

† Obstruction of the basilar may also produce aphasia, and not rarely does, by producing disease of the pons Varolii; but I have purposely omitted from this paper the consideration of loss of speech from disease of the pons.

he managed to say a few words, complaining of pain in the head ; but after this he again became quite speechless, and so remained till his death, four days from admission.

Post-mortem.—Fracture of sixth cervical vertebra and bruised spine. “In cutting into the left hemisphere, a large amount of bruising was found in the gray matter on its external aspect. The brain here was greatly softened, and blood was effused in small patches. The bruising involved the posterior portion of the left anterior lobe and a small portion of the adjoining middle lobe. Each ventricle contained about *ssiv.* of fluid. The septum was firm.”

Although the exact convolutions softened are not mentioned, the description applies exactly to Broca's region. The cerebral injury, moreover, appears to have been limited to that region or its close neighbourhood. It would appear that there was a similar limitation of the lesion in the following cases ; though here also the precise position of the lesion is not so rigidly defined as to enable us positively to assert that it was in the posterior part of the third convolution. That such, however, was the case, there can, I think, from the description, be very small doubt.

CASE XVII.—E. J. was admitted in September 1854, and remained in hospital for two whole years, till his death. A full account of his case was published by Dr. John Ogle, in Beale's *Arch.* i. 81. For my present purpose it is sufficient to say that he had numerous epileptic fits, chiefly affecting the right side, with convulsive movements ; that there was occasional numbness and loss of power on this side, and sometimes swelling and pain ; that his speech was very much affected, and sometimes completely lost ; that he mis-called objects and mispronounced words, saying, for instance, “carsel” for “candle,” “mes-sin” for “medicine,” “called” for “caused,” &c.

Post-mortem.—The dura mater, as a whole, was natural, excepting at one part on the left side, corresponding to the upper and outer portion of the left cerebral hemisphere at about its middle. Here it was firmly adherent to the brain to about the extent of a shilling ; and in a slight degree around this adherent portion its inner surface was coated by a thin film of recent fibrine. This adhesion was effected by means of a callous fibrous deposit, in which was a mass of firm yellow substance. The whole of this indurated material was so intimately united with the nervous substance as to have the appearance of a cicatrix, penetrating it to about the distance of an inch ; and on attempting to remove it, much of the brain came away with it. The brain-texture adjoining was somewhat softened.

I come now to several cases in which the lesion was much

more extensive than in the two last, not being confined to Broca's region, but most certainly including it.

CASE XVIII.—Susan S., admitted July 1863. This woman was a children's nurse, and a fortnight before admission had been out in the sun on a very hot day. She was taken with giddiness, and fell into a pond by which she was standing. She was much frightened by the accident, and ever afterwards had a strange manner. She miscalled things, so that no one could understand her. There was also some difficulty in deglutition. On admission there was no paralysis; but a few days later the right arm became spasmodically flexed, and so rigid that no justifiable amount of force could straighten it. The next day she died.

Post-mortem.—The exterior two-thirds of the left hemisphere were broken down into a mass of greenish purulent matter. The left lateral ventricle was full of purulent fluid. There was a large cavity containing pus in the middle lobe of the left hemisphere.

CASE XIX.—John G., æt. 62. This man was admitted August 27, 1856, for hemiplegia and complete loss of speech. These symptoms had followed on a fit some eight days previously. His urine was highly albuminous. Towards the end of September he could utter a few words; but no other amendment occurred, and he died from gradual exhaustion November 19.

The notes in the registrar's account state the hemiplegia to have been on the *left* side; but I think this must certainly be an error, as it is quite incompatible with the *post-mortem* appearances.*

Post-mortem.—The inner surface of the dura mater in one or two places covered by a thin layer of blood-stained fibrine, and the arachnoid at the upper part of both hemispheres thickened and opaque.

On the left side the upper and middle portion of the cerebral hemisphere was yellowish and "boggy." There was extensive softening of the middle portion of this hemisphere, extending from the surface internally to the base of the left optic thalamus and corpus striatum, the lowest parts of which were involved in the softening. The fornix was softened. There was much fluid in the ventricles.

Kidneys dwindled, granular. A small abscess in one, communicating with a large collection of pus in psoas muscle. Valves of heart atheromatous.

CASE XX.—Joanne C., æt. 16, admitted December 12, 1864. For a week had been ill, chiefly from pain in the left ear. On admission there was no paralysis of the limbs or face. She, however, either could

* I think it is more probable that this was a slip of the registrar's pen, than that the case was one of those excessively rare ones in which the paralysis is on the same side as the lesion, and which are explained by Longet by the absence of decussating fibres in the pons and medulla. *Tr. de Phys.* ii, 222.

not or would not protrude the tongue. The expression of her face indicated intense pain, and she groaned much. In answer to every question she made the same invariable answer, "Our father." She never used any other words. Two days after admission she was found to have lost the use of the right limbs, and there was also great difficulty in deglutition. She died December 16.

Post-mortem.—Extensive caries of left temporal bone. The dura mater covering the left hemisphere distended with pus. The greater part of the arachnoid cavity on this side occupied by thick pus, which had caused the convolutions to be levelled and depressed. The pus covered the greater part of the top and outside of the hemisphere, extending more forwards than backwards. It had extended to the base under the anterior and posterior lobes only, and it covered the whole inner aspect of the hemisphere down to the corpus callosum. The quantity was sufficient to cause considerable compression of the brain.

There remain yet several cases in which it cannot be stated with certainty that Broca's region was affected. In all of them, however, the lesion was in the left hemisphere, and in all so extensive that it is most reasonable to suppose that either that region was itself involved, or the fibres by which that region is connected with the parts below.

CASE XXI.—Archibald B., admitted November 30, 1860. Had enjoyed good health till a fortnight before admission, when he had felt a numbness and loss of power in the right foot. The paralysis had gradually crept up the limb, occupying two days in the process. His right shoulder then became similarly affected, and soon after the whole upper extremity.

When admitted there was complete lax paralysis of the right arm and leg, but no facial paralysis. His mind was clear and his speech articulate, though he was very slow in answering questions. A month later his articulation became very indistinct, and two days after this he entirely lost the power of speech. For the next fortnight he remained quite speechless, though apparently quite sensible, and then died from pleuro-pneumonia.

Post-mortem.—The brain wet; the ventricles rather distended with fluid; the convolutions flattened; the membranes healthy. The greater part of the left hemisphere exhibited extreme softening. This commenced rather above the level of the corpus callosum, and reached down nearly but not quite to the base of the brain. It involved the middle^o and posterior lobes. The optic thalamus was invaded to

* The middle lobe, in the sense in which it is used in our registers, includes a considerable portion of the hinder part of the anterior lobe, if this latter be admitted to go back as far as the furrow of Rolando.

a great extent, but the corpus striatum was nearly if not entirely intact. The softened portion was of a dirty-white colour and almost diffuent. The other parts of the brain were healthy.

CASE XXII.—Sarah H., admitted January 26, 1859. This woman had had a fit of some kind a fortnight earlier, and since that had been speechless and paralysed on the right side. The leg was relaxed, the arm rigid. Whatever question was put to her, she laughed, and said, "Yes." She had another fit in the hospital, and died February 12.

Post-mortem.—On the inner surface of the skull, covering the anterior part of the left hemisphere, was a deposit of new bone, which gave the bone internally a convex instead of a concave outline, and of course pressed upon the brain. The convolutions were flattened. In the substance of the left hemisphere was a peculiar deposit, without any definite structure or exact limits, which pushed over the septum to the right side, and caused the left hemisphere to be nearly twice as broad as the right one. The septum and central bodies on the left side were slightly softened.

CASE XXIII.—John R., admitted January 1865. He had been picked up in the street in a state of insensibility, and brought into hospital, where he remained till his death, a fortnight later. When he recovered consciousness, he was found to be speechless and hemiplegic on the right side, with lax muscles. The only word he could say distinctly was "No." He "talked apparently with intelligence, but running his words together so that it was impossible to understand him."

Post-mortem.—There was a clot of blood of the size of a large hen's egg in the anterior part of the left hemisphere, reaching from nearly the front of the brain to the posterior margin of the corpus striatum. It had broken through the surface of the corpus striatum, and a coagulum was found in the left lateral ventricle. The brain-substance about the clot was softened.

CASE XXIV.—William S., aged 30, admitted into hospital in February 1860. Two years before this had fallen from an apple-tree upon his head, and ever since had suffered from fits. His intelligence had gradually weakened, and he had also become paralytic on the right side. "Although he could articulate perfectly, he had great difficulty in finding words or the ideas which they should represent. He was for a long time unable to recollect his surname. He was in the habit of repeating the same word in answer to all questions. He seemed quite aware of his own deficiency, and used to laugh in a childish way whenever the hesitation was unusually great." Besides these head-symptoms, he had heart-disease, of which he died somewhat suddenly a fortnight after admission.

Post-mortem.—Extensive mitral disease. There was a large cyst full of serous fluid in the left cerebral hemisphere external to the lateral ventricle. The surface of the brain at this part was flattened, and a large part of the hemisphere was gone. The membranes were

matted together, and a large quantity of fluid was contained in the subarachnoid space, which was much enlarged and occupied by a great quantity of cellular adhesions. The principal collection of fluid was bounded externally by thickened pia mater, and internally by the tissue of the corpus striatum and optic thalamus. The latter bodies were almost but not quite destroyed, a small portion being still left projecting into the ventricle. The cerebral substance here was changed in a peculiar manner, being hard and of a brightish-yellow colour. At the lower part of the opposite middle lobe was a small patch of similar degeneration. There was, however, here little if any loss of substance.

CASE XXV.—Philip M., æt. 50, admitted May 10, 1865, with right hemiplegia and complete loss of speech. He had had a fit a month previously, and while gradually recovering the effects of this he had a second three days before admission, which left him in the condition described. At first he was unable to protrude his tongue, but this soon passed off. He remained two and a half months in the hospital without any improvement, and left still speechless. After he left he gradually recovered a considerable degree of power in his limbs, and travelled about the country. But he never recovered the power of speech, as I learnt from his friends. He died about a year after leaving the hospital. There was no post-mortem examination.

General result of the cases.—We have, then, twenty-five cases in which speech was lost or much impaired, and in all of them there was disease of the left hemisphere. This was shown either by post-mortem examination or by sure symptoms during life. In some few there was, it is true, disease on both sides of the brain, but in the large majority the lesion was confined to the left. There is not one single case in our registers in which speech was seriously impaired and the left side of the brain found sound. These cases, even by themselves, would be strong evidence of the correctness of Dax's statement; but when taken in conjunction with the results of other observers, they furnish the most irresistible proof that, in some way or other, the left hemisphere is more intimately connected with the faculty of language than is the right. Thus in thirty-one cases of aphasia collected by Magnan at the Bicêtre and Salpêtrière, there was without exception paralysis on the right side. M. Trousseau, himself an opponent of Dax and Broca,* collected in 1865 all the cases of aphasia he could find. In 125 of these cases there was palsy on the right side, in ten only on the left.

* *Bull. de l'Acad. de Méd.* xxx. 663.

It has been, however, objected that disease of the left hemisphere is very much more common than disease of the right, and that therefore it is only natural that there should be more cases of aphasia associated with the former than with the latter lesion; in fact, that disease of either side will equally produce aphasia, and of that side more frequently which is itself more frequently diseased. This objection would be a sound one, were disease of the left hemisphere more usual than that of the right in any such proportion as 125 to 10. But this is far from being the case. It would indeed appear, from such statistics as I can find, that the left side of the brain is really more frequently the seat of disease than is the opposite one, but only in a very small proportion. In 74 cases of hemiplegia which I collected at St. George's, the right side of the body was paralysed 43 times, the left 32.* Andral gives 73 cases of right hemiplegia against 63 of left; Baillarger (at the Salpêtrière) 58 cases of right palsy, 52 of left. Putting these figures together, we have 174 cases in which the right side was paralysed against 147 in which the opposite side was affected. It is quite plain that this slight difference is utterly inadequate to account for the statistics of aphasia given above.

Admitting, then, Dax's statement to be correct, what is to be said as to the exceptions to his law? How are they to be explained? In the first place, I would remark that they are excessively few. M. Trousseau, with every wish to produce evidence against Dax's and Broca's theory, could only collect ten such. In seven of these ten there was no post-mortem examination. There was paralysis of the left side, and it was inferred that the right side of the brain was diseased, and that the opposite side was sound. But to this it was objected

* It would be rash to draw any very certain inference from so few cases as seventy-four. I cannot, however, but notice that it would seem from these seventy-four cases that women are more liable to hemiplegia on the left side, men to hemiplegia on the right. This is probably in part accounted for by the unexplained fact that hysterical hemiplegia is almost always on the left side. Thus, in Todd's *Lectures on Nerv. System* are six cases of hysterical hemiplegia. In five the palsy is on the left, in one only on the right side. Landouzy (*Traité de l'Hystérie*, p. 114) gives seven cases, and in all the palsy is on the left. Briquet, again, states as the result of his very large experience, that hysterical palsy is three times more frequent on the left than on the right.

with much truth, that disease of one hemisphere does not in any way imply soundness of the other. There may in these cases have been a lesion on the right causing left hemiplegia, and a lesion on the left in Broca's region causing loss of speech but no paralysis. This lesion may have been limited to the gray matter of the surface; and there are several cases in this paper which show that there may then be loss of speech but no paralysis. (conf. cases xvi., xvii.) How careful one must be in estimating these apparently exceptional cases, if there be no autopsy to guide us, is shown by case xv. Had there been no examination of the brain in that case, it might have been quoted as contradicting Dax; for the left arm was affected, not the right. But, on post-mortem examination, it was found that there was obstruction in the vessels of both hemispheres. Secondly, it must be remembered that there are some few cases on record—so few indeed as to make this explanation a very improbable one—where disease of the left hemisphere has been accompanied by hemiplegia on the same side, and not by crossed paralysis, as in the vast majority of cases. A third, and much more probable explanation of these apparent exceptions is one which, to the best of my belief, has not yet been advanced. The loss of speech may have depended on disease of the pons Varolii,* and I have already stated that in such cases the lesion may be either on the right or on the left, and have mentioned what I believe to be the explanation of this, viz. the decussation of the nerve-fibres in passing through the pons (conf. note, p. 101). Lastly, in those very rare cases in which the autopsy has revealed a sound left hemisphere and a diseased right one, we must content ourselves for the present with the explanation already given in a preceding page (p. 88).

* I have not been able to refer to all M. Trousseau's exceptional cases. But to one of them at least the above explanation will apply. This is a case recorded by Dr. Jackson (*Lond. Hosp. Rep.* i. 437, xix.), and included, as are the rest of Dr. Jackson's cases, in Trousseau's collection. The patient in this case was aphasic, and paralysed in the *left* arm and leg; but he was also paralysed in the *right* side of the face. Dr. Jackson explains this by supposing there to have been a lesion on each side of the brain. I think it more likely that there was a single lesion in the pons Varolii; it being well known that such "alternate paralysis" is the ordinary accompaniment of unilateral disease of the pons.

The left hemisphere, then, being specially concerned in speech, the next question is, are all parts of it equally so, or is this faculty located in some limited portion of it, as Broca would have us believe? It would be easy to bring forward abundant cases from our records, showing that most extensive lesions may occur in the left hemisphere, and even in its anterior lobe, without the slightest impairment of speech. I will, however, only give one striking example of this.

Frederic F. died in St. George's Hospital, February 15, 1867. His speech had been perfectly good up to the day of his death. The autopsy showed the following lesions in the head. There was a scalp-wound on the left frontal eminence. The bone here was fractured slightly without any depression. There was pus between the bone and dura mater. This latter was thickened and perforated, and there was a circumscribed abscess in the left anterior lobe, extending from the extreme front back to the corpus striatum, and downward to the orbital plate. In front it came within half an inch of the external surface. The brain-substance round about was yellow, softened, with numerous red puncta. The corpus striatum and optic thalamus on the left side were softened, and the corpus striatum in great part broken down. There was much fluid in the ventricles, and softened fornix. Broca's region was carefully examined, as also the corresponding part of the right hemisphere, and was perfectly sound.

It would appear, then, that all parts of the left hemisphere are not concerned in the matter, nor all parts of the anterior lobe. What part, then, is? The eight cases of embolism of the left middle cerebral artery show that it is some part supplied with nutriment from that source. The rest of the cases harmonise with this conclusion. Such a part, with much besides, is the posterior part of the third frontal convolution; so that our hospital records are compatible with Broca's opinion. The accounts of the post-mortem examinations in the cases I have recorded, made by gentlemen who at the time were not conversant with Broca's theory, and who have therefore not taken pains to distinguish with precision the separate convolutions, do not allow us to go much farther than this. Still, cases v., vi., xvi., xvii., in which Broca's region was, if not exclusively, yet specially the seat of lesion, lend great probability to the accuracy of his conclusion. At any rate, these cases would seem to show that the organs of language are, if not in the exact position which he

has assigned to them, in close proximity to it. Cases of aphasia are, however, by no means uncommon; and it can hardly be doubted that, when so many observers have their attention turned to the subject, pathological observation will soon give a certain answer to the question.

WILLIAM OGLE, M.D.

Additional Note to p. 88.

I wish to make a few additional remarks on the hypothesis dealt with in this page. It may be said, and with justice, that if that hypothesis (Dr. Moxon's) be accepted, we have in it a sufficient explanation of the unilateral localisation of the organ of speech, but no explanation whatsoever of that localisation being almost always on the left side, in preference to the right. It would be as easy to educate the organ on the right as the corresponding organ on the left; and, if it be a matter of indifference, we should expect the selection to fix as often on the one as on the other. If, in answer to this, the almost constant selection of the right hand to perform certain duties be brought forward, it may be objected that the cases are not quite analogous. It may be said—though I do not think this is really the case—that the preëminence of the right hand is not the natural consequence of our organisation, but is merely the result of the bias given knowingly by the parent to the child. The parent, himself right-handed, puts the pen, the knife, or other instrument into the child's right hand, and thus the child grows up to use that hand from habit in preference to the other. In the case of the brain, no such intentional selection can of course occur. If, then, the left hemisphere be almost invariably chosen by nature for the process of education, there must be some difference or other between the two hemispheres which determines that choice. Can this difference be pointed out? I think it may. Owing to the well-known arrangement of the arteries which rise from the aortic arch, the left hemisphere receives by the carotid a more direct, and therefore freer, supply of blood than does the right. Probably from this cause, but at any rate from some cause or other, the convolutions of the anterior lobe of the left hemisphere are developed at an earlier period than those of the opposite side. This has been made out by the conscientious researches of Gratiolet, whose authority in such a matter no one will call in question. In this fact we have, I think, a sufficient explanation of the matter. Nature selects for the process of education that anterior lobe which is the more mature, and therefore the more apt, or alone apt at that period, to receive it. In this same fact we find a probable reason for most men being right-handed. The right hand, being governed by the left hemisphere, will have the same

advantage in time over its fellow as has the left hemisphere over the right one. Its education will begin earlier, and, where one hand alone has to be educated, this will be the one chosen.

This suggestion is, at any rate, sufficiently probable to deserve further inquiry. In any future post-mortem examinations of left-handed persons, or of aphasic patients who have the right hemisphere alone diseased, it will be well to see whether there is not some abnormal arrangement of the arteries which spring from the arch, and whether such arrangement does not give an advantage to the right hemisphere in its blood-supply. Should such turn out to be the case, it will afford strong evidence in favour of my suggestion. Should it not so turn out, we shall still have the undoubted fact that the convolutions of the left anterior lobe are developed earlier than the corresponding ones of the opposite side ; but some other explanation must be found for this than the arrangement of the blood-vessels.