The Lumleian Lectures

ON

SOME PROBLEMS IN CONNEXION WITH APHASIA AND OTHER SPEECH DEFECTS.

Delivered before the Royal College of Physicians of London,

BY H. CHARLTON BASTIAN, M.A., M.D. LOND., F.R.S.,

CENSOR OF THE COLLEGE; PHYSICIAN TO UNIVERSITY COLLEGE HOSPITAL AND TO THE NATIONAL HOSPITAL FOR THE PARALYSED AND EPILEPTIC.

LECTURE I.[1]

Delivered on April 1st, 1897.

MR. PRESIDENT AND GENTLEMEN,—The modern interest n, and development of knowledge concerning, aphasia and other speech defects dates from the publication of certain memoirs by Broca, some six and thirty years since, when he attempted to localise what he termed the "faculty of articulate language" in a limited convolutional region of the left cerebral hemisphere. The publication of his cases and conclusions formed the starting point for a whole new series of investigations, whose result has been a remarkable development in our knowledge of the localisation of functions in the cerebral cortex, while the discussions to which these investigations have given rise have materially helped to lead to a better understanding of the working of the complex cerebral mechanisms needed for the carrying on of speech and thought. We are thus at the present day capable of dealing with the subject of speech defects from a much broader basis of discovered facts, as well as with a greater critical insight than was at all possible at, or even long after, the time when Broca wrote his famous memoir. Very much, however, remains to be discovered before the many differences of opinion that exist concerning obscure and complicated points in connexion with the nature and exact mode of production of speech defects are likely to be set at rest.

The special tendency of aphasia and other forms of speech defect to be associated with disease of the left rather than of the right hemisphere is now a well recognised fact. This holds good for right-handed but not as a rule for left-handed persons. In these latter aphasic defects are produced by disease in similar parts of the right cerebral hemisphere. It is believed, therefore, that motor incitations for acts of speech are accustomed to pass off in the main from one cerebral hemisphere, and that whether this shall be from the left or from the right hemisphere becomes determined principally by the increased dominance, or slightly earlier development, of one of them, brought about more or less remotely in association with right- or with left-handedness.

Although we shall here deal with what are known as "acquired defects of speech"—that is, such defects as may have supervened after the power of speaking has been attained—still, it seems desirable that a very brief reference should be made as a preliminary to defects of speech resulting either from congenital disease or from diseases occurring at some date prior to the manifestation of articulate speech. The most important of these congenital defects is deafness, which of itself entails mutism, the individuals thus afflicted being known as "deaf mutes." It must be borne in mind, however, that this mutism or dumbness may also be brought about by absolute deafness occurring from any cause after birth, but before the child has begun to talk, or even after it has learned to talk, up to the fifth or the seventh year. In cases of the latter type the child soon (when left without the customary guidance in articulatory acts derived through the sense of hearing) forgets how to speak and becomes dumb. In addition to this class of cases there are also those of congenital idiotcy without deafness, in which the child never learns to talk. There are also other cases, allied to the last, in which, owing to some intracranial lesion occurring either before, during, or soon after birth, the brain becomes so damaged as to arrest the development of the child's mental as well as of its motor powers. In some of the less severe examples of this type (now commonly spoken of as "birth palsies") that have come under my observation speech has been merely deferred—perhaps till the fourth, fifth, or even the sixth year—and then after a time has become established in a natural manner. In other cases the occurrence of epileptic fits seems to be the retarding cause.

One of the most remarkable cases known to me of deferred speech in connexion with the occurrence of epileptic attacks happened in one of my own patients. In the year 1877 I was consulted concerning the health of a boy who was then twelve years old, and had been subject to epileptic fits at intervals. The first of these fits occurred in infancy, when the patient was about nine months old. Towards the end of the second year the fits seemed to have ceased, the hearing was (as it had been) good, and the child appeared to be of average intelligence—to be well, in fact, in all respects except that he did not talk. When nearly five years old the little fellow still had not spoken a single word, and about this time two eminent physicians were consulted in regard to his "dumbness." But before the expiration of another twelve months, as both his mother and father assured me, on the occasion of an accident happening to one of his favourite toys, he suddenly exclaimed, "What a pity!" though he had never previously spoken a single word. The same words could not be repeated, nor were others spoken, notwithstanding all entreaties, for a period of two weeks. Thereafter the boy progressed rapidly, and speedily became most talkative. When seen by me he spoke in an ordinary manner without the least sign of impediment or defect.

Such a sudden beginning to speak for the first time without previous prolonged trials and failures is a matter vastly transcending in importance the sudden resumption of speech when it has been for a time suspended in consequence of brain disease. No explanation of such a fact seems possible except on the supposition that speech has now become a truly automatic act for human beings, and that if children do not speak at birth this is in the main due to the circumstance that their nervous systems are still too immature. No such untaught acts of speech would, however, be possible unless development had been taking place in a normal manner and unless the auditory sense and intelligence had been unaffected. The occurrence of some emotion may in such a case afford a stronger stimulus, under the influence of which the duly organised speech mechanisms become called into action.

Some curious cases of congenital speech defect were described by Hadden to which the term "idioglossia" has been applied. These children have to a certain extent a language of their own, so that when asked to repeat phrases they make use of definite sounds of their own instead of those proper to the words that should be employed. The sounds which they substitute are said to be always the same for the same words. Some of these patients seem to have been capable of writing correctly from dictation, and they have also shown a fair amount of general intelligence.

THE VARIOUS KINDS OF WORD MEMORY.

According to Sir William Hamilton, "Memory strictly so denominated is the power of retaining knowledge in the mind, but out of consciousness. I say, retaining knowledge in the mind but out of consciousness, for to bring the *retentum* out of memory into consciousness is the function of a totally different faculty (recollection). . . . It is not enough that we possess the faculty of acquiring knowledge and of retaining it in the mind but out of consciousness; we must further be endowed with a power of recalling it out of consciousness into consciousness—in short, a reproductive power (recollection). This reproductive power is governed by the laws which govern the succession of our thoughts—the laws, as they are called, of mental association." This definition of memory implies the notion of an organic change taking place in definite nerve elements on the occurrence of each sensory or intellectual process—that is, the notion of a permanent nervous modification of some kind, plus the possibility of its renewal in more complete form from time to time. We may therefore suppose that on fitting occasions, by the intervention of associational activity, there will be revival in more complete form of something like the original molecular

[1] Lectures II. and III. will be delivered on April 6th and 8th respectively.

activity in the nervous elements concerned with the primary perceptional or intellectual process of this or that kind. It is not essential that the memorial revival of the sensory impression or of the intellectual process should after multitudinous repetitions be associated with any distinct conscious phasis. What Sir William Hamilton termed the *retentum* may, indeed, be revived as a mere unconscious nerve action—a link in a perceptive process or in a chain of thought represented merely (as John Stuart Mill put it) by "certain organic states of the nerves." This latter consideration is especially worthy of note from the point of view of the importance of revived kinæsthetic impressions for the guidance of movements, seeing that their revival may be unattended by any distinct conscious phasis; and much the same thing may often be said concerning that memorial recall of words in the auditory centre which immediately precedes speech.

From what has already been said it is evident that "loss of recollection" by no means implies nor is it to be taken as synonymous with "loss of memory." For instance, a patient may be unable to recollect words—that is, spontaneously revive them—for ordinary speech when his memory for such words, nevertheless, exists unimpaired, as may be shown by the fact that the patient is able at once to repeat the words in question when he hears them pronounced or sees them written. His defect, therefore, may consist in a mere lowered activity of the auditory word-centre, in which words are primarily revived during thought. "Loss of recollection" may, in fact, depend upon one or other of two causes: either (*a*) upon some diminished functional activity—that is, diminished readiness to be roused—in the central nerve mechanisms in which the *retentum* is, so to speak, stored or rendered possible of revival; or else (*b*) upon some defect in this or that set of commissural fibres (associational channels). "Loss of memory," however, in the strict sense of the term implies disease of, or serious damage to, the central nerve units in which the particular *retentum* is stored up or registered.

Although it is important from a scientific point of view to make such a distinction as has been above pointed out, it will be found both convenient and practical to let the term "amnesia" stand for loss of recollection as well as loss of memory of this or that kind.

From what has been said it follows, that all cases of amnesia (in the broad sense of the term) ought, from an anatomical or localising point of view, to be divided into two generic groups: (*a*) cases in which there is centric defect (either structural or of marked functional type), with which there will often be loss of memory of words as well as loss of recollection; and (*b*) cases in which there is merely commissural defect (mostly structural), with which there may be loss of recollection of words, but no necessary loss of word-memory. It will be one of my objects in the present lectures to dwell upon the fact (which I pointed out some ten years ago) that it is often in the case of speech defects extremely difficult, if not impossible, from clinical evidence alone to decide whether the underlying lesion or default leading to a particular kind of amnesia be centric or commissural in seat. And yet from the point of view of the localisation of the lesion such a decision may be a matter of much importance, seeing that if the lesion were centric we should look for it in one part of the brain, while if it were commissural it might be found in a region comparatively remote therefrom.

In the case of words there are three distinct kinds or physiological types of memory to be considered—one of them existing in two forms, so as to make four varieties in all. These varieties of verbal memory are as follows:—1. Auditory memory: the memory of the sounds of words—that is, of the auditory impressions representative of different words. 2. Visual memory: the memory of the visual appearances (printed or written) of words—that is, of the visual impressions corresponding with different words. 3. Kinæsthetic memory.[2]—(*a*) the memory of the different groups of sensory impressions resulting from the mere movements of the vocal organs during the utterance of words (impressions from muscles, mucous membranes, and skin)—that is, of the kinæsthetic impressions corresponding with the articulation of different words, which for the sake of brevity I have proposed to speak of as "glosso-kinæsthetic" impressions; and (*b*) the memory of the different groups of sensory impressions emanating from muscles, joints, and skin, during the act of writing individual letters and words—that is of the kinæsthetic impressions corresponding with the writing of different letters and words, which I have for similar reasons proposed to speak of as "cheiro-kinæsthetic" impressions.[3]

The organic seat of each of these four different kinds of word-memory is in relation with its own set of afferent fibres; and the several centres must also be closely connected with one another by commissural or associational fibres, so that the memory of a word or the recollection of a word in one or other of these modes doubtless involves some amount of simultaneously revived activity in one or two of the other word-centres.

The relative intensity or importance (in the process of recollection of words for ordinary speech) of the memorial revival in each of these centres is probably subject to more or less marked variations in different individuals. In the majority of persons, as I pointed out in 1869, the revival of words in the auditory centre is the most potential process, and that which occurs first in order of time. This seems to be now very generally admitted.

THE LOCALISATION OF THE DIFFERENT WORD-CENTRES.

Although I am not a believer in the complete topographical distinctness of the several sensory centres in the cerebral hemisphere, I consider it clear that there must be certain sets of structurally related cell and fibre mechanisms in the cortex, whose activity is associated with one or with another of the several kinds of sensory endowment. Such diffuse but functionally unified nervous networks may differ altogether from the common conception of a neatly defined "centre," and yet for the sake of brevity it is convenient to retain this word and refer to such networks as so many "centres."

Looking to the extremely important part that words, either spoken or written, play in our intellectual life and to the manner in which they are interwoven with all our thought-processes, it becomes highly probable that most important sections of the auditory and the visual sensory centres are devoted to the reception, and consequently to the revival in thought, of impressions of words: and for convenience of reference it is permissible to speak of these portions as auditory and visual "word-centres" respectively. Similarly, there must be what I have termed kinæsthetic word-centres of two kinds (the one in relation with speech-movements, and the other with writing movements) holding a like all-important relation to the expression of our thought by speech and writing. It is possible that the particular parts of the general auditory and visual centres which are in relation with word-impressions may be more or less distinctly defined, like the analogous parts of the general kinæsthetic centre that are in relation with speech or with writing movements. Certain it is that there are some varieties of amnesia in which the part of the visual centre in relation with words seems to be specially at fault (as in "word-blindness"), just as there are other cases in which the part of the auditory centre in relation with words is either wholly or partially inactive (as where we have to do with different degrees of "word-deafness")—in each case without defect in other parts of the general visual or auditory centres, as evidenced by the fact that the persons so affected can still quite well see and recognise ordinary objects, or hear and recognise the nature of ordinary sounds.

In regard to the visual centre as a whole, it seems now to be established that it is more or less diffused through the convolutions on the inner aspect of the occipital lobe and probably even more widely throughout this lobe. The particular part of the visual centre that is most concerned with the appreciation and memorial recall of words—or, in other words, the destruction of which most certainly gives rise to word-blindness—is now fairly well settled. There is much evidence to show that this region corresponds with the

[2] These forms of word-memory were first definitely stated by me to be purely sensory in papers on the Physiology of Thinking (Fortnightly Review, 1869) and on the Muscular Sense (Brit. Med. Jour., April, 1869); and the name "kinæsthetic" was subsequently (The Brain as an Organ of Mind, 1880, p. 543) applied to the complex groups of impressions resulting from movements of this or that part of the body.

[3] Other French writers, as well as Ballet, attribute to Charcot the doctrine that "le mot n'est pas une unité, mais un complexus" (Le Langage Intérieur, 1886, p. 13) because he also dwelt upon these four different kinds of word-memory. Charcot's lectures on Aphasia were delivered in 1883, but M. Ballet will find a full description of these four different kinds of word-memory in my book The Brain as an Organ of Mind, 1880, p. 696, or in the French translation (Le Cerveau et la Pensée, tome ii., p. 222), published in 1882.

angular gyrus either alone or in association with part of the supra-marginal lobule—and therefore that it is situated just beyond the confines of the occipital lobe, and in the region originally assigned by Ferrier, upon the basis of his experiments with monkeys, as the centre for vision as a whole.

In regard to the localisation of the general auditory centre considerable doubt now exists, since the researches of Schäfer and Sanger-Brown do not support Ferrier's allotment of this endowment to the upper temporal convolution. Curiously enough, however, it again happens that the localisation of the part of the general auditory centre most concerned with the appreciation of words (as based upon clinico-pathological evidence in man) must be regarded as being in the posterior half or two-thirds of the upper temporal convolution. The above-mentioned results of Schäfer and Sanger-Brown as to the localisation in monkeys of the general sense of hearing were of a negative character, and cannot be said to afford any definite evidence against this presumption as to the site of the auditory word-centre in man.

The situation of one of the two kinæsthetic word-centres can be rather more certainly localised. Having elsewhere stated very fully my reasons for believing that the so-called "motor centres" of Ferrier and others are really sensory centres of kinæsthetic type by means of which movements are guided,[4] I shall not now attempt to set forth the evidence in favour of this opinion, but shall merely state my belief that Broca's region—namely, the posterior part or foot of the third frontal and the inferior part of the ascending frontal convolutions—is in reality the part of the brain to which I have been alluding as the "glosso-kinæsthetic" centre. The situation of the "cheiro-kinæsthetic" centre cannot be localised with nearly as much confidence. The tendency for some years has been to follow Exner, who believes it to be situated in the posterior part of the second frontal gyrus, though, as we shall see later, the evidence in favour of this localisation is at present extremely scanty. All that can be said on this point, therefore, is that we know approximately where to look for the cheiro-kinæsthetic centre.

For the purpose of our discussion, then, it may for the present be assumed that the two kinæsthetic word-centres are situated as above stated: that the auditory word-centre is situated in the posterior half or two-thirds of the upper temporal convolution; and the visual word-centre in the angular and part of the supra-marginal convolutions. It must also be assumed, upon grounds subsequently to be set forth, that these last-named word-centres are connected together by a double set of commissural fibres. We must likewise suppose that two other important sets of commissural fibres exist between the different word-centres—namely, one set through which the auditory word-centre acts upon the glosso-kinæsthetic centre for the production of speech movements, and another by means of which the visual word-centre acts upon

FIG. 1.

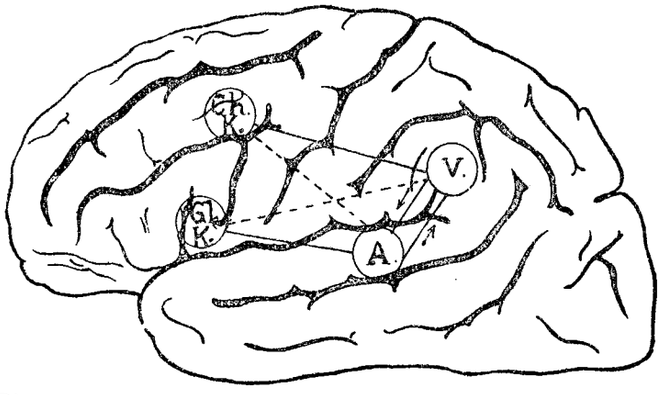


Diagram showing the approximate sites of the four word-centres and their commissures.

the cheiro-kinæsthetic centre for the production of writing movements.

In the study of speech defects it is therefore necessary to consider the effects of lesions in the following situations; (*a*) in the different kinds of word-centres; (*b*) in the different commissures by means of which these centres are connected with one another; (*c*) in the internuncial fibres connecting the two kinæsthetic word-centres with their related motor-centres, in the bulb and in the cervical region of the spinal cord; and (*d*) in these motor-centres themselves which are concerned with the actual production of speech and writing. But before dealing with any of these problems in detail a few other aspects of the questions relating to word-memory, as well as the modes of activity of the brain in perceptive and speech processes require to be considered.

THE PRIMARY SITE OF REVIVAL OF WORDS IN SILENT THOUGHT.

It seems clear that words are the symbols with which our thoughts are inextricably interwoven, and that the revived feelings, ideas, or "images" of words may enter into thought processes by a more or less simultaneous renewal of activity in different regions of the cerebral cortex. There may be a revival of sounds of words as we hear them in ordinary speech; there may be a revival of visual impressions of words as we have seen them in written or printed characters; and, lastly, there may be a revival of the feelings of muscular contractions concerned in the pronunciation of words. Of these modes of "ideal" recall of words the two former are distinct and easily recoverable, while the latter is vague and difficult of conscious realisation. Let anyone contrast his idea of the sound of the word "London," or his idea of the appearance of the word when printed or written, with his idea of the muscular and other feelings associated with the articulation of the same word, and the inferiority in definiteness and recoverability of the latter will at once become obvious.

It is, however, a matter of extreme importance for the due understanding of the different kinds of speech defect and for the success of our endeavours to refer them to defective activity in this or that physiological region of the hemispheres that we should definitely know in what sensory region of the cortex words are principally recalled to mind during ordinary thought-processes. Two distinct views radically opposed to one another have been advocated on this subject.

There is the view (1) that words are revived as "motor processes"—that is, as faint excitations of the processes occurring in motor centres during the articulation of words; and (2) there is the view that words are revived in ordinary thought in the main as auditory ideas or images. The former view has for a long period been promulgated by Hughlings Jackson, and has more recently received the strong support of Stricker, both of them regarding Broca's region as a motor rather than as a sensory centre. The latter view is that which the writer has now for many years advocated. The fundamental nature of my opposition to the former view may be gathered from the fact that I have for many years expressed the opinion that motor centres, wherever they may be situated, are parts whose activity appears to be wholly free from subjective concomitants. No "ideal" reproductions seem ever to take place in such centres; they are roused into activity by outgoing currents, and, so far as we have any evidence, the induction in them of molecular movements which immediately afterwards issue through cranial and spinal motor nerves to muscles are, like those which they engender, simply physical phenomena.[5] It is true that the altered condition of the muscles and of contiguous parts induced by these outgoing stimuli together engender a body of ingoing impressions, the terminus for which is the kinæsthetic centre. This latter is therefore a true sensory centre, and in it images of movements or "ideal movements" may be revived in a more or less vague manner as already indicated.

But, even if we adopt what appears to me to be the more legitimate view that articulatory movements as well as movements in general are represented in the cerebral cortex only by sensory centres, there are still, I think, good reasons for rejecting the notion that the "material of our recollection" in the use of words during silent thought is primarily revived as glosso-kinæsthetic impressions in Broca's centre. The principal reasons opposed to this view seem to me to be as follows. In the first place it must be evident from the mode in which speech is acquired by the child that during the few months in which words enter into the simple trains of thought, before he has acquired the power of articulating them for himself, they must be revived as

[4] "The Muscular Sense: its Nature and Cortical Localisation," Brain, April, 1887, and "On the Neutral Processes Underlying Attention and Volition," Brain, April, 1892.

[5] The Brain as an Organ of Mind, 1880, p. 599.

auditory impressions. Secondly, there is, as we have seen, a much greater definiteness of impression and readiness of recall for auditory than for articulatory feelings; and so far, therefore, there is a greater fitness in the former for serving as the "material of our recollection" of words in ordinary thought processes. Thirdly, there is reason to believe that revived auditory feelings continue after the acquirement of speech by the child to have the same relation to his thought-processes as they must have had before his acquirement of the power of speaking. If this were not so it would be impossible to understand why total deafness supervening in a child in full possession of speech as late as the fifth, sixth, or even the seventh year, will certainly entail dumbness unless the child be drilled in lip-reading, that is, unless the primary incitation to acts of speech be gradually transferred from the auditory to the visual centres. Fourthly, because, as we shall subsequently find, there is much evidence against this view to be derived from the study of speech defects, and none that I am aware of telling unmistakeably in its favour.

It seems to me to be an error to attempt to settle such a question by endeavouring to ascertain which form of word-memory reveals itself most in consciousness; and I venture to think that the recent principal advocate of the view that words are primarily revived during silent thought as "motor processes," relies too much upon what is in reality an untrustworthy method—that of introspection. By concentrating his attention upon the genesis of his own speech, Professor Stricker inevitably brings its expressive side into undue prominence. As Taine says[6]: "Plus on imagine nettement et fortement une action, plus on est sur le point de la faire... quand l'image devient très lumineuse elle se change en impulsion motrice."[7]

The primary revival of words during thought takes place, I submit, in the great majority of persons by a sub-conscious process in the auditory centre, and tends to be immediately followed by correlated revivals in the glosso-kinæsthetic centre, and these again by incipient or complete activities in the bulbar motor centres. It may be perfectly true that kinæsthetic memories vary in intensity in different individuals, as do auditory and visual memories; and it might have been thought that Stricker and also Ballet (who adopts his view in a more discriminating manner) were to be counted as persons in whom the former kind of memory is highly developed, but for the fact that Ballet expressly states[8] his inability voluntarily to recall cheiro-kinæsthetic impressions. He believes, moreover, for reasons given, that the same holds good for Stricker. Thus they cannot voluntarily recall the kinæsthetic impressions associated with the act of writing a word, but they say they can recall the kinæsthetic impressions associated with the articulation of the same word, even although the movements in the latter case are much more of an automatic type. These apparently contradictory results are easily explicable in accordance with my views, when one considers how the thought of a word naturally runs on to an incipient articulation[9]; while, on the other hand, the mere thought of the same word has no appreciable tendency to evoke writing movements. The negative results of Ballet and Stricker with cheiro-kinæsthetic revivals of words would seem, therefore, to have all the force of a crucial experiment and to throw great doubt upon their supposed ability primarily to revive words in the glosso-kinæsthetic centre.

It seems pretty certain, therefore, that the real linguistic counters for thought are the auditory and visual memories of words. And in regard to these two I believe that in the very large majority of persons it is the auditory word-memory which is first revived in silent thought. This view is now very generally adopted, as may be seen by reference to the works of Ross[10] and Bernard.[11] It appears also to be the view of Herbert Spencer, since he says[12]: "Our intellectual operations are, indeed, mostly confined to the auditory feelings (as integrated into words) and the visual feelings (as integrated into ideas of objects, their relations and their motions)." Although the first stage in the revival of words seems to occur, however, in the auditory centre, the molecular disturbance thus initiated is immediately transmitted to a varying extent in two directions. It is transmitted to the visual word-centre on the one side and to the glosso-kinæsthetic centre on the other—to the latter strongly where the thought is to issue in speech, and to the former strongly where it is to issue in writing.

There can be no doubt that in some persons the visual centres as a whole are more highly developed and organised than the auditory centres, and *vice versâ*. The existence of such differences has been thoroughly shown by Francis Galton.[13] Thus he took steps to test the power of what he calls "visualising"—that is, the ability of persons to see with the mind's eye distinct images of objects in their natural grouping and colouring. The one hundred answers that he received as to the power possessed by the persons selected of visualising the breakfast table to which they had sat down in the morning disclosed an extraordinary range of variation in this respect. One of those who had the highest power of visual recall answers: "Thinking of the breakfast table this morning, all the objects in my mental picture are as bright as in the actual scene." One of those who had the lowest power answers: "No individual objects, only a general idea of a very uncertain kind." Galton adds: "There are a few persons in whom the visualising faculty is so low that they can mentally see neither numerals nor anything else; and again there are a few in whom it is so high as to give rise to hallucinations." In this general sense persons may well be classed as "visuals" and "auditives" respectively; and we may thus indicate for this or that person which is the more potent sensory endowment.[14]

Supposing, however, that a person is a "visual" in this general sense, it should not, in my opinion, be taken as necessarily implying that visual memories of words are for him the first to be revived in silent thought. If it were so we should expect to find speech greatly interfered with in many cases of simple word-blindness; but this seems comparatively rarely to be met with, the contrast in this respect being most striking between destruction of the visual and destruction of the auditory word-centres respectively. The primary revival of words may, perhaps, still occur in a visual in the auditory centre, only in such a person these primary revivals may be strongly backed up and reinforced by visual images. So that where the auditory word-centre is damaged in such a person its action, as a leader in the memorial recall of words, might to a certain extent be taken on by the visual word-centre; while in a person who is not a "visual" but little compensation of this kind could occur for the loss of the auditory word-centre. Thus the clinical effects in the form of speech disturbance would be different and altogether more marked in the latter case. It will be found that many recorded cases of speech defect lend support to these views, and that this, in fact, is the real practical outcome of all that has been said by Charcot and his followers as to the division of persons (in reference to the interpretation of speech defects) into four categories—"auditives," "visuals," "motors," and "indifferents"; a doctrine which has been fully set forth by Ballet.

I contend that this doctrine must not be taken to mean anything more than that the different kinds of word-memory referred to in the first three types may be met with in different degrees of excellence, and that in the fourth type there is no one kind of memory which is developed to a preponderating extent. In the latter class there would be no ground for supposing that the ordinary rule as to the primary revival of words taking place in the auditory centre is ever altered. As to the existence of persons representative of the third class I have already expressed my doubts—that is to say, I can find no good reasons or evidence to show that words ever arise in silent thought primarily in the kinæsthetic centres. I doubt whether these memories are capable of separate voluntary recall, and do not believe there is any evidence to show, as Bernard says,[15] that "the motor centre for speech may become independent of the sensorial centre which had presided over its education."

The case is altogether different in regard to individuals of the second class—the "visuals"—because not only does the power of memorial recall in the visual centre vary immensely

[6] De l'Intelligence, troisième édition, tome i., p. 482

[7] See his work, Le Langage et la Musique, Paris, 1884.

[8] Le Langage Intérieur, 1886, p. 55.

[9] Ballet, in fact, says, loc. cit., p. 52:—"Chez moi, comme chez la plupart des moteurs je pense, la parole intérieure devient souvent assez vive pour que j'arrive à prononcer à voix basse les mots que dit mon langage intérieur." What he says on the next page shows that he is not a strong "visual," but does not tell against his being a strong "auditive." His better memory of a lecture after delivering it might be explained by the help derived from auditory or kinæsthetic impressions of the words, or from the two in combination.

[10] On Aphasia, 1887, p. 114.

[11] De l'Aphasie, 1885, p. 49.

[12] Principles of Psychology, vol i., 1870, p. 187.

[13] Inquiries into Human Faculty, 1883, p. 83.

[14] On this subject many interesting details have been given by Ballet, loc. cit., pp. 17-45.

[15] Loc. cit., p. 48.

in different persons, as we have seen, but there is also good reason to believe that in a small minority of persons the primary revival of words during a process of silent thought may take place therein, just as it does in the act of reading. Thus Galton says[16]: "Some few persons see mentally in print every word that is uttered; they attend to the visual equivalent and not to the sound of the words, and they read them off usually as from a long imaginary strip of paper." It is possible, of course, that a person possessed of this high visualising power, whilst he may be thus aided in the delivery of a speech previously written, may nevertheless, in a process of silent thought, conform to the ordinary rule and revive words voluntarily in his auditory centre. But it may be otherwise with some few persons, so that, as Ribot supposes, they may habitually think and represent objects "by visual typographic images." Something of this kind we are bound to suppose must occur in a word-deaf person whose auditory word-centre is destroyed and who is yet able to speak—a rare conjunction that has occasionally been met with; just as we are bound to suppose that when a congenitally deaf and dumb child is taught to speak by the lip-reading process he brings this about by means of a primary revival of visual images, which act directly upon the glosso-kinæsthetic centre and thence upon the motor centres in the bulb.[17]

Bernard has cited[18] a remarkable instance of a patient who possessed a visual memory exceptionally strong, whilst his auditory memory was proportionally weak. In this patient the visual images of words and figures were evidently predominant during thought processes. "If he recited a lesson whilst at college, or an extract from a favourite author later on, two or three readings were sufficient to fix in his memory the page with its lines and its letters, and he recited by mentally reading the desired passage, which, at the first summons, presented itself with the greatest distinctness." Ballet[19] also quotes a letter from a librarian at Geneva which is extremely interesting. He writes: "When I think of a word or a phrase I see very distinctly this word or this phrase printed in ordinary characters, or written in my own writing or that of another person; the letters of a word are distinct from one another, and the intervals between each word written in black appear to me also. I see them in white. All my reproductions of words are visual." The same author mentions an orator, Hérault de Séchelles, who was accustomed, as it were, to read his speeches; and cites an epigram of Charma, also a "visual," who, speaking of the class to which he belongs, said, "Nous pensons notre écriture, comme nous écrivons notre pensée."

Undoubtedly, then, it would seem that there are certain exceptional persons who, as it were, read rather than hear their thoughts; and in whom, as Ballet says, the visual images of words acquire such an importance that they alone constitute the medium of their internal speech. Still, in spite of these exceptions, the general rule is that auditory images constitute the most potent representations of words, whilst visual images form the most potent representations of ordinary external objects.

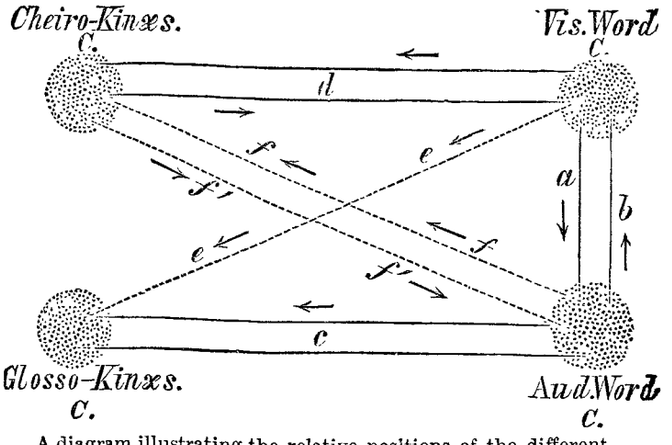
THE REVIVAL OF WORDS FOR SPEECH IS A COMPLEX PROCESS

The views just expressed refer, as I have said, to the seat of the primary revival of words in memory, because there is strong reason for believing that the activity when once initiated does not limit itself to a single centre. It must be borne in mind that the structural relations existing between the different seats of word-memory and the modes in which these are functionally related is in accordance with what occurs in ordinary processes of perception. In regard to such a process I have elsewhere said[20]: "When any one constituent of a natural cluster of sensations comes within the range of the corresponding sense organs of an animal the other possible impressions composing the cluster (and representing the organism's knowledge of the external object) become simultaneously nascent in memory, so that the object is perceived or recognised. If in a dark room my hand comes upon an orange or a book, either of these sensations of touch will immediately fuse with nascent ideas of other possible sensations from the same object (whichever it may be), so that this object is perceived as a present external reality. ..... Thus it happens that an object is recognised immediately or intuitively, not so much by the mere single or double impression present, as by the blending of this with more or less fully revived memories of other impressions which have at various times been associated with the same object. Truly enough, as Bain says, 'When we see, hear, touch, or move, what comes before us is really more contributed by the mind itself than by the present object.' ..... It is therefore by the simultaneous consciousness and fusion, as it were, of the subjective side of various new and old impressions that a present object is perceived and recognised. It could only be by the previous establishment of structural communications between the severally related sensory cells (in different centres) that the excitation of those of any one order would suffice to revive more or less strongly in other groups just such molecular changes as like objects had on previous occasions excited. And it may be easily understood that the molecular movements initiated by any one or two sense impressions may start from such groups of cells and thence flow over into all communicating channels between them and the cells of other related groups."

In a similar manner it may be supposed that the revival of activity in the auditory centre during the voluntary recall of words does not remain limited to that centre, but gives rise, as I have already said, to molecular movements in two directions—that is, forwards to related portions of the kinæsthetic centre and backwards and upwards to related portions of the visual centre—though with different degrees of intensity in different persons.

It is of importance to remember that for ordinary persons (that is, for those who are neither congenitally blind nor congenitally deaf) the four memories of words seem to be mainly called into play in definite couples—namely, the auditory and the glosso-kinæsthetic revivals taking place during articulate speech, and the visual and cheiro-kinæsthetic revivals taking place during ordinary writing. By this I mean that in expressing one's self in spoken words memories of such words are first principally revived in the auditory centre, and that the nerve units thus called into activity immediately rouse through commissural fibres (see Fig. 2, *c*) the corresponding

FIG. 2.



A diagram illustrating the relative positions of the different word-centres and the mode in which they are connected by commissures. The connexions indicated by dotted lines indicate possible but less habitual routes for the passage of stimuli.

glosso-kinæsthetic elements before the pronunciation of the word can be effected through the aid of the motor centres in the bulb. Probably in a healthy brain there is some amount of concurrent activity during speech in related portions of the visual word centre.

Again, when we are expressing our thoughts by writing, though the memories of the words are probably first revived in the auditory word-centre, corresponding memories are almost simultaneously revived (through the intervention of the audito-visual commissure, *b*) in related parts

[16] Loc. cit., p. 96.

[17] In the case of a deaf and dumb child taught to speak and understand others by means of hand and finger movements their thought-counters would be combined visual and kinæsthetic impressions, or in the case of one who had been taught to read much from early life they might be "visual typographic images." On the other hand, in the case of a congenitally blind person who has been taught to read aloud by means of raised letters and words excitation of the centres for touch and kinæsthesis would constitute the initial processes in the act of reading aloud, although revived auditory impressions might constitute, as in ordinary persons, the habitual thought-counters. A patient of the former class whose history has been reported by E. Fournier (Essai de Psychologie, Part II., chap. v.) says: "Je sens quand je pense que mes doigts agissent, bien qu'ils soient immobiles. Je vois intérieurement l'image que produit le mouvement de mes doigts."

[18] Le Progrès Médical, July 21st, 1883.

[19] Loc. cit., p. 44.

[20] The Brain as an Organ of Mind, p. 176.

of the visual word-centre, and from this region stimuli pass by another commissure (*d*) to corresponding cheiro-kinæsthetic elements before the actual writing of the words can be effected through the instrumentality of motor centres in the cervical and upper dorsal regions of the spinal cord.

There can be no doubt, in fact, that the functional association existing between the auditory and the glosso-kinæsthetic centres, as well as that between the visual and the cheiro-kinæsthetic centres, is of the closest kind. No less intimate, however, is the bond of association between the activity of the auditory and the visual word-centres themselves. These latter centres are often necessarily called into associated activity in immediately successive units of time. This happens, for instance, in two such common processes as reading aloud and writing from dictation.

In reading aloud the primarily excited visual word-centre must arouse, through (*a*) the visuo-auditory commissure, related parts of the auditory word-centre, since this is the part which ordinarily calls the glosso-kinæsthetic centre into activity, whence properly coördinated incitations issue from the cortex, in order to call into play the motor centres in the bulb.

Again, in writing from dictation the sounds of the words reach the auditory word-centre, and the activity thus aroused becomes transmitted through (*b*) the audito-visual commissure to related parts of the visual word-centre, this being the part that usually rouses the cheiro-kinæsthetic centre into activity, whence properly coördinated incitations issue from the cortex in order to call into play the motor centres in the cord concerned with the act of writing.

In exceptional cases it seems that the ordinary functional coupling of the auditory with the glosso-kinæsthetic and of the visual with the cheiro-kinæsthetic word-centres is not adhered to. Thus the deaf-mute thinks in the main with revived visual symbols (either of hand or of lip movements) and it is from the organic seats of these that incitations pass to related parts of the glosso-kinæsthetic centre (*e*, *e*). A similar stimulation of these centres direct from the visual word-centre seems occasionally to obtain in persons who are not deaf-mutes. We have already assumed it to be possible for some few "visuals," and subsequently for the interpretation of certain cases of disease in which the auditory word-centre has been damaged we shall find ourselves obliged to have resort to such a supposition.

Again, in those children who have been born blind, but have nevertheless ultimately learned to write, a direct association must become established between the auditory and the cheiro-kinæsthetic word-centres (*f*, *f*). The same kind of associated activity between these two centres must exist in certain other persons not born blind, seeing that some patients suffering from word-blindness owing to destruction of the visual word-centre are able, nevertheless, to write, either spontaneously or from dictation.

This functional unification of the word-centres of which I have been speaking does not, however, remain in a state of isolation. Words that are heard are first of all associated in the mind of the child with external objects, so that such auditory impressions become linked, by means of associational fibres, with the organic seats of the several sensory impressions—also freely connected with one another—that the child has been able to derive from this or that object. Thus the name subsequently becomes revived as part of the perceptive process whenever the object is again presented. The sight of the mother recalls the name "Mamma," just as the sound of this word would revive the corresponding visual, tactile, and other images. After a time the auditory representative of the name becomes reinforced by glosso-kinæsthetic impressions as soon as the child learns to utter the word; later by visual impressions, when it learns to read, and by cheiro-kinæsthetic impressions when it has learned to write.

The several components of word-percepts are thus brought, not only into relation with one another, but become no less intimately associated with the several sensory components of object-percepts. The result is that the hearing or the sight of the name of any object immediately calls up in the older child or in the adult an idea of the object, just as its presentation to sight or other sense produces a nascent activity in the several centres in which its name is registered, though mainly in the auditory and the visual centres.

Words soon become to a very large extent the symbols whereby we carry on our thoughts, and this thinking by means of words becomes all the more thorough as though's become more complex. We can think of a particular person or of a particular plant as well by recalling the visual image as by recalling the name. But when in thinking we have to recall general names, such as "animal" or "tree," or still more abstract names such as "virtue" or "vice," it becomes certain that in silent thought we use the words as symbols for the more or less complex ideas which they represent. And if we bear in mind that the seats in which these words are registered (our word-centres) are in organic and functional relation with the seats of registration of the corresponding percepts, concepts, &c., we are enabled in a measure to understand how the revival of the word in the mind (as the thought-counter) is associated with an almost simultaneous activity in the seats of registration of the corresponding percepts and concepts.

We may thus recognise how it happens that in simple acts of perception, and still more in simple thought processes, we have no limitation of cerebral activity to narrowly localised centres, but rather widespread processes of activity in very varied regions of the cortex, and that, too, in both hemispheres of the brain. In our talk about individual centres and their functions we are apt to forget how much the brain acts as a whole even in operations that seem comparatively simple, and many of those who have written on aphasia have, as I venture to think, not sufficiently taken into account the fact that the name constitutes an integral element of the percept or of the concept.

On the Different Modes of Excitation of the Word-centres, and on the Reason of their Functional Predominance in the Left Hemisphere.

It is important to recollect that word-centres are naturally called into activity in states of health in three modes, but that failure in the possibility of their excitation by one or other of these modes occurs in various morbid conditions, leading to this or that kind of speech defect. The three modes of excitation are these: (1) By means of "sensory" impressions coming from without; (2) by "association"—that is, by impulses communicated from another centre during some act of perception or thought process; and (3) by "voluntary" recall of past impressions, as in an act of recollection. It is convenient for practical purposes to separate these second and third modes of calling into activity the perceptive centres; still they are probably closely related to one another and scarcely separable in nature, although the associational processes in the case of "volitional" excitation may be so difficult to trace that the recall assumes a quasi-spontaneous character.

The excitability of the centres—that is, the molecular mobility of their nervous elements—may vary with age, state of health, or the existence of different morbid conditions. Their excitability may be so much lowered that they are only capable of responding to powerful stimuli; so that while volitional recall (or "recollection") may be impossible within their province, such centres may still be capable of acting in "association" with others—that is, in an automatic manner during an ordinary process of thought—or at least under the "sensory" stimulus which initiates a perceptive process. At other times the excitability of the perceptive centres may be unduly exalted, so as to lead to hallucinations, illusions, and a wholly different class of defects such as are often met with among the insane.

From what has been said in a previous section it will be seen that I entertain doubts whether kinæsthetic word-memories of either kind are capable of being revived alone in a voluntary manner.

As to the causes which have determined the greater or almost exclusive influence of the left hemisphere in inciting speech movements, and therefore in acting upon the bulbar motor centres for words, only conjectures can be offered. It is, however, now pretty generally agreed that the immediate or proximate cause is to be found in the fact of the predominant use of the right hand, which entails a greater functional activity upon the left cerebral hemisphere. This view rests principally upon the now ascertained fact that in the great majority of cases in which aphasia has occurred as a result of brain lesions in the right hemisphere (with or without the association of left hemiplegia) those so affected have been left-handed persons.[21] It would thus seem to

[21] According to Seguin, out of 266 cases of aphasia he found 243 with right and 17 with left hemiplegia; that is, somewhere about 6 per cent. W. Ogle, on the other hand, from inquiries among 2000 hospital patients, found that 85 of them were left-handed; that is, about 4½ per cent.

follow that the predominant use of the right hand or of the left hand carries with it, as one of its associated effects, the leading activity in the production of speech by the left or the right hemisphere respectively; and that we must consequently push our question further back, and inquire as to the causes that have led to this predominant use of the right hand.

This problem has been considered by Pye-Smith,[22] and also in a more exhaustive manner by William Ogle,[23] but can only be briefly alluded to here. It has been thought to depend largely upon tribal or social customs and early tuition of young children by their mothers, though doubt has been thrown upon these views as giving any adequate explanation of the problem. William Ogle looks rather to certain peculiarities in the mode of origin of the left and right carotids respectively as calculated to favour a slightly freer blood supply to the left cerebral hemisphere. If this were really so, it is conceivable that it might after a time have led to a slightly earlier development of the convolutions on the left side of the brain (which has been affirmed to occur by Gratiolet, though denied by Carl Vogt and Ecker), and thus perhaps have led to a preferential use of the right hand in the early and more definite movements of the child. Such preferential use being once started and maintained through several generations, it is only to be expected that it would continue; for if the effects of use and disuse are inherited as, with Herbert Spencer, I believe to be the case (in spite of all that Weismann says to the contrary) heredity would coöperate with the original cause in confirming and making general this preferential use of the right hand.

But whatever may have been the original cause of this now very general attribute of right-handedness—and the chief difficulties of the problem with which we are concerned lie here—it would easily follow that with its continuance in process of time the left hemisphere should become (as it has been found to be) slightly heavier than the right, and that the left carotid might become (as it is said to be) very slightly larger than the right carotid. It is practically certain that the great preponderance of right-hand movements in ordinary individuals must tend to produce a more complex organisation of the left than of the right hemisphere. We may confidently look for the existence in it of the organic basis of a vastly greater and more complex tactile experience; and as movements of the right hand and arm are more frequent, both as associated factors of this experience and in other ways, we have also a right to suppose that the kinæsthetic centres will be similarly developed to a notably greater degree in the left hemisphere.

Many years ago I ascertained a fact which then seemed very difficult to understand—namely, that the specific gravity of the cortical grey matter of the brain in the left frontal, parietal, and occipital regions is often distinctly, though slightly, higher than that from corresponding regions of the right hemisphere. Full details as to this will be found in a paper "On the Specific Gravity of the Human Brain," published in 1866.[24] Now such an increase in specific gravity might easily be produced by the greater number of cells and associational fibres which the extra sensory and derivative functions above referred to would necessarily entail.

Thus it may, in brief, be said that this preponderating activity of the left hemisphere in regard to tactile and kinæsthetic impressions (about which there is no room for doubt) may have much to do with the fact that the left hemisphere is the more potent and seems to take the lead in some thought processes, as well as in giving rise to the voluntary excitations which determine the muscular acts involved in articulate speech. A greater convolutional complexity of the lower part of the left frontal lobe as compared with the right, which has been found to exist, is thought to be a result of this preponderant activity of the left hemisphere in the production of articulate speech. Some evidence in favour of this view is to be found in the fact that Broadbent, in his examination of two brains taken from left-handed persons that were submitted to him by William Ogle, found in them the reverse condition—that is, that the greater convolutional complexity was on the right rather than on the left anterior lobe.[25]

There still remains the question why one cerebral hemisphere only should be efficiently educated for the perception of speech and for the production of speech movements, when, seeing that the bulbar motor centres are bilateral, it might seem that such centres would be likely to receive their stimuli from both hemispheres. In partial reply to this question Moxon, in a very able paper,[26] long ago suggested that the call upon attention was so great for the production of the extremely elaborate movements concerned in speech that the necessary concentration of attention would be much facilitated if this process of education were limited to one hemisphere. Whatever may be thought of this ingenious suggestion, nothing better has hitherto been forthcoming.[27]

What has just been said as to the action of the left hemisphere rather than the right in the production of speech must be understood with certain reservations. It must not be supposed that the right hemisphere remains entirely uneducated, either in regard to the comprehension or to the production of speech. Little is said by writers generally on this subject, and what has been said has reference principally to the third frontal convolution. A hypothesis as to the functions of this part of the brain has been enunciated by Hughlings Jackson,[28] and another view, as to what is figuratively termed the "overflow of education into the opposite hemisphere," has been expressed by Wyllie.[29] But neither of these hypotheses appears to me to be in accord with existing knowledge.

The most important points to be borne in mind in reference to this subject would seem to be these. All the movements concerned in speech are movements produced by symmetrically placed muscles on the two sides of the body; there is just as much reason, therefore, for the registration of kinæsthetic impressions resulting from speech movements in the right as in the left third frontal convolution. Again, it cannot be supposed that auditory impressions from spoken words do not pass from each ear to similar regions in the opposite cerebral hemisphere; and our present knowledge makes it equally improbable that the visual impressions of words are not registered in a visual word-centre in each hemisphere. For each of these three sets of afferent impressions, therefore, there is, as I believe, no question of an "overflow" from one to the opposite hemisphere; on the contrary, each hemisphere receives its own proper share of ingoing impressions, and doubtless registers them in a more or less similar fashion. That this should be so seems an obvious truth, though it is one that hitherto appears to have been very imperfectly realised. Again, it may be taken as established, for reasons which will subsequently appear, that the separate centres composing each of these pairs are brought into functional union by means of commissural fibres forming part of the corpus callosum. So far, therefore, we seem bound to admit that each hemisphere has the chance of being equally educated, so far as the mere *reception* of speech impressions is concerned.

It is, however, when we come to the executive side of speech functions that the great difference begins to appear between the relative activity of the two hemishperes of the brain. For reasons which we have previously been dimly endeavouring to indicate, the executive speech functions become relegated to one hemisphere, and this leading hemisphere, generally the left, becomes for this and for the other reasons which we have adduced more highly organised. The fact that the volitional impulses for the incitation of speech pass off from this hemisphere leads of necessity to the gradual perfecting of the associational channels between the auditory and the glosso-kinæsthetic centres, as well as between the auditory and the visual word-centres of the left hemisphere, and also to the perfecting of

Left-handedness, curiously enough, was found to be "twice as common in men as in women." Ogle shows, too, how very frequently there is hereditary transmission of this peculiarity.

[22] Guy's Hospital Reports, vol. xvi., 1871.

[23] Transactions of the Royal Medical and Chirurgical Society, 1871.

[24] Journal of Mental Science, pp. 28, 32.

[25] Transactions of the Royal Medical and Chirurgical Society, 1871, p. 294.

[26] British and Foreign Medico-Chirurgical Review, 1866, p. 481.

[27] Moxon's paper is, indeed, in other respects remarkable, looking to the date at which it was written. Thus he speaks of spoken words as represented in Broca's region by "educated associations of movements"; and the meaning that he attaches to this phrase is rendered evident further on when he dwells upon the "inconceivable pitch of education which is given to these supra-motory departments, if I may so call them, of the brain, which hold ready for use the memorial forms of outgoing words," or still better where he says, "The situation of the ideas of *associated motions* which form the faculty of speech is supra-motory, whilst the situation of the ideas of *associated sensations* which form the faculty of language comprehension is supra-sensory."

[28] Brain, vol. ii., 1879, p. 327.

[29] The Disorders of Speech, 1895, p. 262.

the outgoing channels of communication between these sensory centres and the true motor centres in the bulb. The corresponding associational and outgoing channels in the opposite hemisphere, however, being but little used, may remain comparatively undeveloped.

This difference in the degree of activity of the two cerebral hemispheres during speech would tend to become more and more accentuated in future years, and would in all probability lead to a much higher grade of functional activity, even on the receptive side, in the three kinds of word-centres pertaining to the leading hemisphere.

Views of this kind as to the partial education of the word-centres of the opposite hemisphere will be found to be of considerable importance when we come to speak of the modes in which destruction of one or other of the word-centres in the leading hemisphere may be compensated—or, in other words, of the way in which a cure may be brought about in this or that form of speech defect.

DOES CONCEPTION TAKE PLACE IN A CENTRE ALTOGETHER APART FROM PERCEPTION?

The first authoritative writer on defects of speech who started the notion of the existence of an altogether separate centre for conception or ideation was Broadbent. This he did in a very important memoir, "On the Cerebral Mechanism of Speech and Thought," published in 1872.[30] Whilst there adopting some views which I had previously published on the subject of the cerebral processes that occur in perception,[31] he made a departure from them in the direction above indicated. The functions that I spoke of as being carried on in the perceptive centres he divided into two stages. He said: "There is a primary or rudimentary perceptive act in which the external cause of a given set of sensations is recognised as such, and in which the simple attributes, as of form, colour, hardness, &c., are perceived. And there is a higher degree of elaboration in which, by the combination or fusion of perceptions derived from the various organs of sense, a conception or idea of an object as a whole is obtained. This is a new and distinct process, and is usually accompanied by the affixing of a name to the object. To the 'perceptive centres' I relegate simply the translation of sensations into rudimentary or primary perceptions, and these centres must lie somewhere in the marginal convolutions which receive radiating fibres from the crus and central ganglia, upon which therefore impressions will first impinge, and which are symmetrically combined by the fibres of the corpus callosum. The higher elaboration, the fusion of various perceptions together, and the evolution of an idea out of them, will be accomplished not by radiation from one perceptive centre to all the others, but by convergence of impressions from the various perceptive centres upon a common intermediate cell area, in which a process analogous to the translation of an impression into a sensation and of a sensation into a primary perception will take place. This intermediate cell area will form a part of the supreme centre, and will be situated in the superadded convolutions which receive no radiating fibres."

In a subsequent communication some years later these views were still further developed by Broadbent.[32] The centre for concepts was then termed the "naming centre," whilst a related higher motor centre was postulated as a "propositionising centre," in which words other than nouns were supposed to be registered, and where sentences were formulated preparatory to their utterance through the instrumentality of Broca's centre.

This supposed convergence of impressions from the various perceptive centres into a new region in which "conception" and "naming" take place is a view totally different from my own, which nearly thirty years ago was thus expressed:[33] "In the perceptive centres the primary impressions made upon the organs of sense are converted into 'perceptions proper'—that is to say, they receive their intellectual elaboration, and this elaboration implies an intimate cell and fibre communication between each perceptive centre and every other perceptive centre, since one of the principal features of a perceptive act is that it tends to associate, as it were, into one state of consciousness much of the knowledge which has been derived at different times and in different ways concerning any particular object of perception. An impression of an object, therefore, made on any single sense centre on reaching the cerebral hemispheres, though it strikes first upon the perceptive centre corresponding, immediately radiates to other perceptive centres, there to strike upon functionally related cells, all this taking place with such rapidity that the several excitations are practically simultaneous so that the combined effects are fused into one single perceptive act."[34] Thus the work which Broadbent supposes to be done in his "naming" or "concept" centre is according to my view carried out by the simultaneous activity of the different perceptive centres, and certain annexes which are derivative developments therefrom, of which I shall subsequently speak. And, again, I have postulated, instead of a single separate "naming centre," the existence of four "word-centres" as important and intimately correlated parts of the more general auditory, visual, and kinæsthetic centres.

Consequently I never seek to explain certain cases of speech defect, as he and others whom I am about to mention not unfrequently do, by supposing the existence of lesions in a localised centre for "concepts," or of lesions involving the commissural fibres proceeding to or issuing from such a centre.

With variations in detail, views similar to those of Broadbent as to the existence of a special centre for concepts were subsequently published by Kussmaul[35] and Charcot,[36] whilst the views of the latter were adopted and further promulgated by Bernard[37] and Ballet.[38] The existence of a separate centre for concepts is also postulated by Grasset.[39]

The views of Kussmaul were embodied in an elaborate and complicated diagram which it is unnecessary to describe. A more simple and easily to be comprehended diagram was also produced by Charcot (and is to be found in the work of Bernard), which is based upon the same principles as the scheme issued by Broadbent, with the exception that he omits the "propositionising centre" and also adopts my view as to the existence of separate word-centres. He, however, makes the several sensory impressions converge to an "ideational centre" in order that their meaning should be realised, and indicates that the speech centre (that of Broca) and the centre for writing movements (both of them as "motor" centres) are called into activity directly from this ideational centre, as well as from the auditory and the visual centres respectively.

Some diagrams that have attracted much attention were also published by Lichtheim in illustration of his well-known paper on aphasia.[40] They likewise show a centre for concepts altogether apart from the sensory centres, and in his endeavours to explain the different kinds of speech defect he refers two of his types to a destruction of supposed afferent and efferent fibres proceeding to and from this conceptual centre. While, therefore, his diagrams and his language in many parts of his paper would make one think that he adopted in full the view as to the existence of a wholly separate centre for concepts, he says towards the end of his paper[41] "this has been done for simplicity's sake," and that he does not "consider the function to be localised in one spot of the brain, but rather to result from the combined action of the whole sensory sphere." This statement, though it is quite in accordance with my own view, seems to me to invalidate much of his exposition and to make it almost impossible for him legitimately to suppose, as he does, that two of his types of speech defect are to be explained by the supposition of the existence of a lesion involving either the afferent or the efferent fibres pertaining to such a widely diffused centre. In addition there is the serious defect that his diagrams are at variance with his views on this important subject.[42]

My dissent from these particular views of Broadbent

---

[30] Transactions of the Royal Medical and Chirurgical Society, 1872, pp. 180, 181, and 191.

[31] On the Muscular Sense and the Physiology of Thinking, Brit. Med. Jour., May, 1869.

[32] Brain, vol. i., 1878.

[33] Brit. Med. Jour., May, 1869.

[34] From this it is evident that there can in reality be only one perceptive centre, although its different component parts were formerly by myself (as well as by Broadbent) spoken of as "perceptive centres" because their functional activities were integral components of a perceptive act. I recognise now that it would have been better not to have used this term as a name for these centres—that they are, in fact, more appropriately spoken of as sensory centres.

[35] Ziemssen's Cyclopædia, vol. xiv., p. 779.

[36] Le Progrès Médical, 1883.

[37] De l'Aphasie, 1885, p. 45.

[38] Le Langage Intérieur, 1885.

[39] Leçons de Clinique Médicale, 1896 (Montpellier).

[40] Brain, 1885. The reader will find several of the diagrams previously referred to in an article on "The Sensory Side of Aphasia," by E. A. Shaw, in Brain, 1893, p. 492.

[41] Loc. cit., p. 477.

[42] I shall later state what I believe to be the interpretation of his seven types of speech defect, when it will be seen that they may be explained without any necessity for supposing the existence of lesions in any such parts.

was expressed in 1880,[43] and again more strongly against them as well as against the allied views of Kussmaul, Charcot, and Lichtheim, in 1887.[44] I am glad to say that this dissent from these doctrines has been followed by that of A. de Watteville,[45] Ross,[46] Allen Starr,[47] and Wyllie,[48] all of whom have likewise decided against the propriety of postulating the existence of a separate centre for ideas or concepts.

My opposition to this postulation of a separate "centre for concepts" was based originally upon psychological considerations. It seemed to me wholly unnecessary and at variance with what appeared to be the real nature of the process of perception.

Then, again, I am unable to find any clear evidence from clinical data tending to prove the existence of a separate "centre for concepts"—or, in other words, any existing forms of speech defect that can only be explained by supposing the existence of a lesion in such a centre or in the course of its afferent or efferent fibres. I am convinced that the supposed necessity for assuming the existence of a "centre for concepts," when seeking to interpret different forms of speech defect, may in many cases be obviated by a fuller recognition of the different degrees of functional excitability that may obtain in the auditory and the visual word-centres respectively. We shall see that their molecular mobility may be so much lowered that they are only capable of responding to powerful stimuli. Thus, whilst volitional recall or recollection may be impossible within their province, they may still be capable of acting in association with other centres—as when reading may be fluent though voluntary speech is greatly impaired; and still more easily under a direct sensory stimulus—as when a word is repeated which the patient has just heard pronounced.[49]

Another cause that has led to this postulation of a "centre for concepts" is traceable, I think, to an inadequate realisation of the nature of a perceptive process and of the fact that a name may and does constitute an integral part of the complexus of revived sensory impressions which go to constitute such a process.

Again, as it would be quite easy to show, perceptive processes vary greatly in complexity and merge by insensible gradations into processes of conception. It seems thoroughly legitimate, therefore, to suppose that these latter more specialised modes of mental activity, whilst having their roots in perceptive centres, must be completed in outgrowths therefrom—that is, in parts of the brain which are in close relation structurally and functionally with the several sensory centres. I have commonly spoken of such regions as "annexes" of the perceptive centres.

Of late Flechsig has called special attention to four areas of the cortex that differ from the sensory areas, since they are neither in relation with afferent nor with efferent fibres. He assumes[50] that these regions subserve higher mental functions than those carried on in the sensory centres, and terms such regions "association areas." These regions seem, therefore, to correspond with what I have referred to above as "annexes of the perceptive centres." They occupy a large proportion of the cerebral cortex, and are thus located by Flechsig: (1) in parts of the pre-frontal lobes; (2) a large portion of the temporal lobes; (3) a considerable area in the posterior parietal region; and (4) the island of Reil. These four fairly well-defined areas are, as above stated, not directly connected with afferent or with efferent fibres, and in addition to this two other reasons are given for supposing them to be concerned with the carrying on of higher functions. Flechsig points out, in the first place, that these regions remain immature and completely devoid of myeline for several months after birth, though the sensorial centres have arrived at comparative maturity; and, secondly, that these association centres are the parts which are especially developed in the brain of man as compared with that of the lower animals.[51]

It is only fair to Broadbent to point out that more than twenty years previously he had cited almost exactly these regions of the cerebral cortex as parts that were neither in direct relation with peduncular fibres nor with those of the corpus callosum, and that he had attributed to these regions just the same functions as those now assigned to them by Flechsig.[52] He adds: "Now the convolutions which I have enumerated as having no direct communication with the crus, central ganglia, or corpus callosum are, in the first place, those which are latest in order of development, and on this ground alone might be supposed to be concerned in the more strictly mental faculties which are latest in their manifestations. They are those which constitute the difference between the human cerebrum and the cerebrum of the quadrumana; and it would, moreover, seem to accord with the general plan of construction of the nervous system and with what we know of the mental operations that these convolutions, which are withdrawn, so to speak, from direct relation with the outer world, should be the seat of the more purely intellectual operations."

It is, I think, perfectly legitimate to suppose that the annexes of the sensory centres, to which I have previously referred, tend to be developed in the directions above indicated by Broadbent and Flechsig, though how much of these territories they occupy must remain altogether uncertain. It seems also probable that there is no sharp line of demarcation between these annexes and the several sensory areas, and that *the combined sensory areas together with the annexes are accustomed to be thrown into functional activity more or less simultaneously*. Thus the processes of perception and conception, together with revival of linguistic symbols, are probably almost as inseparable in their localisation as they are in their nature and modes of occurrence, and their anatomical substrata must be supposed to occupy a very considerable extent of the cortex of both hemispheres.

A final question now remains for consideration related to this other which we have just been considering. It is this—Where are we to look for the registration and revival of words in the cerebral cortex? It may be said that this question has been already answered. And so it has tentatively and in a general sense. We have laid stress upon the existence of four different kinds of memorial registration of words and the probable sites of such word-centres in the hemispheres. We have indicated also that the glosso- and the cheiro-kinæsthetic centres constitute definite parts of the general kinæsthetic centres, and that the auditory and the visual word-centres probably also constitute more or less separate parts of the general auditory and visual centres.

Something additional, however, may now be said concerning the sites of these word-centres which could not well have been said at an earlier period, and that is that each of them is probably to be found partly on the confines of its percept centre and partly on that of its related annexe. This supposition is made because some words (especially names of things, persons, and places) are in closest relation with sensory centres; whilst others, such as verbs, adjectives, prepositions, and other parts of speech constituting the framework of language, are in closer relation with conceptual processes. These two modes of functional activity are, as I have said, absolutely inseparable from one another, and therefore the several word-centres must be in most intimate relation both with the sensory centres and with their annexes.

If the views above expressed be anything like an approximation to the truth, it may be judged how vain it would be to attempt to base our explanation of any of the different kinds of speech defect upon the supposed existence of some one separate centre for "ideation," "conception," or "naming" which is connected by means of commissures (long enough and separate enough to permit of isolated damage) with sensory centres on the one side and with motor centres on the other. I am pleased to find that the views at which I have arrived on this important subject—while they differ so much from those held by some of the most authoritative writers on speech defects—are nevertheless in very close accord with those formed by one very distinguished writer and thinker on these subjects—viz., the

---

[43] The Brain as an Organ of Mind, p. 636.

[44] Brit. Med. Jour., Nov., 1887.

[45] Le Progrès Médical, March 21st, 1885.

[46] On Aphasia, 1887, p. 123.

[47] Brain, 1889, p. 97, where Starr says: "The results of pathological observation fail to give any support to the hypothesis of an 'ideational centre' which Broadbent and Kussmaul have introduced into their diagrams."

[48] The Disorders of Speech, 1894, pp. 230 and 235. Wyllie, however, I think, tends to convey an erroneous impression by representing in a diagram on p. 276 of his work the seats of word revival in a lower plane and of percept revival in a higher plane, and assuming that the stimulation of Broca's centre takes place from the seat of percept revival rather than from the auditory word-centre. This seems to be also the position of Lichtheim, judging from his Fig. 7 and what he says in reference thereto, loc. cit., p. 477.

[49] Examples will be given later when speaking of the defects due to disabilities in the auditory word-centre.

[50] Neurologisches Centralblatt, 1894, pp. 674 and 809; and Gehirn und Seele, Leipzig, 1895.

[51] Since the above was written I have received from Déjerine the reprint of a communication made by him to the Société de Biologie, on Feb. 20th, 1897, in which he contests these views of Flechsig.

[52] Transactions of the Royal Medical and Chirurgical Society, 1872, p. 178.

late Dr. James Ross. Thus, in his work "On Aphasia," he gave expression to the following views (page 125) :—"And on passing from thinking by percepts to thinking by concepts, and from that to thinking by abstracts, there are no new centres introduced, but only a complication upon complication of the one perceptive centre. All that can be said is that the correlative of perceptive thinking is excitation of that portion of the cortex of the brain which is directly connected with the sensory inlets; of conceptive thinking, excitation of portions of the cortex which are indirectly connected with them; and of abstract thinking, excitation of portions which are still more remotely connected with them. It must, however, be remembered that the effective working of the portions of the cortex which are remotely connected with the sensory inlets will in a great measure depend upon the integrity of those that are in direct relation with them. ..... Let us now attend to the effects of dissolution of this structure. A destructive lesion of the portions of the cortex which are most remotely connected with the sensory inlets would destroy the capacity of the patient for highly abstract reasoning, and would no doubt inflict considerable damage on the language in which abstract thought is embodied, but this condition would not be recognised as an aphasia; and even the intermediate portions of the cortex in which conceptive thought is carried on might be seriously damaged without giving rise to a special speech disorder, inasmuch as any impairment of speech which might be present would only be regarded as a part of a general decay of the reasoning faculties. When, however, the lesion is situated in or near to the sensory inlets a disorder of language results which is out of all proportion to the general impairment of the reasoning faculties." All that has been set forth above is thoroughly in harmony with the dictum of Max Müller, who says: "Though sensations, percepts, and concepts may be distinguished, they are within our mind one and indivisible. We can never know sensations except as percepts, we can never know of percepts except as incipient concepts."

The Goulstonian Lectures

ON

THE CHEMISTRY AND PATHOLOGY OF GOUT.

Delivered before the Royal College of Physicians of London,

BY ARTHUR P. LUFF, M.D., B.Sc, F.R.C.P. LOND.,

PHYSICIAN IN CHARGE OF OUT-PATIENTS IN ST. MARY'S HOSPITAL, AND LECTURER ON FORENSIC MEDICINE IN ST. MARY'S HOSPITAL MEDICAL SCHOOL.

LECTURE II.[1]

Delivered on March 25th.

THE SOURCES AND FORMATION OF URIC ACID IN PATHOLOGICAL CONDITIONS OTHER THAN GOUT IN WHICH IT APPEARS IN THE BLOOD.

MR. PRESIDENT AND GENTLEMEN, — Although I hold the opinion that in health uric acid is only formed in the kidneys, and that the uric acid found in the blood in gout is absorbed from the kidneys after formation in those organs, yet it must be borne in mind that there are other diseases besides gout in which uric acid appears in the blood, and in connexion with which it has most probably *not* been absorbed from the kidneys, but has been formed elsewhere in the system. I will therefore briefly consider what these pathological conditions are and what are the probable sources of the uric acid in such conditions. The investigations of von Jaksch, Klemperer, and others have conclusively established that the presence of uric acid in the blood is not a pathognomonic sign of gout, and also that uric acid may appear in quantities in the blood and be eliminated without causing gout.

Blood disorders accompanied by the presence of uric acid in the blood.—Von Jaksch[2] found uric acid in the blood in cases of both primary and secondary anæmia, pernicious anæmia, and splenic tumour. He also found it in the blood in conditions inducing dyspnœa—notably in heart disease, pleurisy with effusion, pulmonary catarrh, pneumonia, and emphysema. Klemperer[3] has recently confirmed the results of von Jaksch and others as to the presence of uric acid in the blood in leucocythæmia, and many observations have been made of the increased excretion of uric acid that accompanies this disease. Laache[4] found a daily excretion of 3·7 grammes (nearly six times the average normal amount) in a patient suffering from this disease. Bartels[5] observed a daily excretion of 4 grammes (more than six times the average normal amount). Stadthagen[6] found a daily excretion of 2 grammes (three times the average normal amount). Bohland and Scherz[7] found a daily excretion of 1·4 grammes (twice the average normal amount). Von Jaksch[8] concluded that the occurrence of uric acid in the blood was due to diminution of the oxidising activity of the red corpuscles and to consequent storing up in the blood of the uric acid formed in the body, which, according to his view, is normally oxidised and destroyed. Horbaczewski's view, which will be considered later, that the formation of uric acid is due to the disintegration of leucocytes, would equally apply, since in all the diseases in which von Jaksch found uric acid in the blood leucocytosis was present. Moreover, there is no experimental proof to support the view that uric acid is oxidised and destroyed by oxygenated blood; on the contrary, there is experimental proof that the process of oxygenation can, in the presence of nuclein, produce uric acid instead of destroying it.

Renal diseases accompanied by the presence of uric acid in the blood.—Von Jaksch[9] found uric acid in the blood in all the cases of renal disease that he examined, the proportions being especially large in cases of granular kidney disease and uræmia. Von Jaksch's results were confirmed by Klemperer,[10] who examined the blood in cases of contracted kidney and found uric acid always present.

Lead poisoning accompanied by the presence of uric acid in the blood.—Sir Alfred Garrod[11] examined the blood of nine patients suffering from plumbism and who had never suffered from gout, and found appreciable quantities of uric acid in the blood of seven out of the nine. Dr. Oliver[12] refers to the early stage at which anæmia becomes a prominent symptom of lead poisoning. Although no doubt the kidney mischief which occurs in connexion with plumbism is responsible for the appearance of most of the uric acid in the blood by interfering with its excretion by the kidney cells, yet it is possible that a small amount of the uric acid may result from the slight leucocytosis accompanying the anæmia of plumbism.

Fevers and absence of uric acid in the blood.—Von Jaksch found no uric acid in the blood of patients suffering from typhoid fever, intermittent fever, and acute rheumatism, nor in connexion with diseases of the liver, stomach, and intestines, when unaccompanied by anæmia. His observations seem undoubtedly to prove that the presence of uric acid in the blood is not a factor in the production of the so-called uric acid intoxication of fever. Fever, indeed, appears to influence unfavourably the production of uric acid. It is evident that in connexion with certain diseases, especially those in which leucocytosis occurs, uric acid may be present in quantities in the blood and yet not give rise to gout. The reason, in my opinion, is that in such diseases the kidneys being in a sound condition can readily eliminate the uric acid. A proposition that I wish to put forward is that the seat or site of formation of uric acid is a different one in gout to what it is in those blood diseases and disorders in which uric acid occurs in the blood without the development of gout. In gout I believe that all the uric acid present in the blood is absorbed from the kidneys owing to some affection of those organs—functional or organic—which interferes with the proper excretion of the uric acid manufactured in the kidneys. In cases of contracted granular kidney disease and in cases of plumbism the uric acid present in the blood is, I believe, derived from

[1] Lecture I. was published in THE LANCET of March 27th, 1897.
[2] Deutsche Medicinische Wochenschrift, 1890, xxxiii., p. 741.
[3] Ibid, 1895, xxi., p. 655.
[4] Klinische Urinanalyse, 1892, p. 31.
[5] Deutsches Archiv fur Klinische Medicin, Band i., p. 13.
[6] Virchow's Archiv, Band cix., p. 390.
[7] Pflüger's Archiv, Band xlvii., p. 13.
[8] Ueber die Klinische Bedeutung von Harnsäure und Xanthinbasen im Blut, 1890.
[9] Loc. cit.
[10] Loc. cit.
[11] A Treatise on Gout, 1876, p. 241.
[12] Goulstonian Lectures on Lead Poisoning, THE LANCET, March 7th, 14th, and 21st, 1891.