



APHASIA STUDIED IN PATIENTS WITH MISSILE WOUNDS

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THE objects of this investigation were to find out how far aphasic manifestations can be classified into useful groups, whether such classification corresponds with topographical arrangements in the cerebral cortex, and whether the approach to aphasia can be simplified by adequate terminology.

Material, Tests, and Records

Forty-six convalescent cases of penetrating missile wounds of the dominant hemisphere, having some relevant symptoms, were selected at the Military Hospital for Head Injuries, Oxford, and subjected to various tests. Two were left-handed, with wounds of the right hemisphere, and two others had multiple brain injuries. One was practically illiterate, probably owing to a congenital defect which left his general intelligence fairly intact.

Each patient was given a short explanation and then his response to questions about his speech trouble was taken down verbatim. This was followed by the spontaneous naming by free association of a maximum number of animals in one minute, and a vocabulary test. These tests allowed estimation of the disturbance of articulation, inflection, and speed, of the tendency to paraphasia, jargon, and syntactical errors, and of the difficulty in finding words for ideas. The patient's responses to the first sixteen words of the Stanford-Binet vocabulary test were recorded verbatim, and found to be useful as a direct, if somewhat formal means of estimating his expressive power. Eight words were given orally, then the patient was asked to read and explain the remaining eight. Next, ten coloured pictures of simple objects were exposed to be named. The patient was then asked to point to that pictured object which was named by the examiner, and finally to the one the name of which was printed on a slip. This was an easy test for naming, and for the understanding of written and spoken words.

Understanding was further tested by the patient's ability to execute simple commands with regard to his body, the most difficult involving three different actions to be done synchronously. Reading monosyllables (three-letter words) with a time limit of one minute was another check on speed and ability to convert visual symbols into those of sound. Reading

of seven figures from one to four digits, and eventually a twenty-word sentence including three or four rather difficult words, completed the evaluation of this aspect of speech.

The writing tests were graduated from a dictation of ten words, consisting of one to ten letters, to the figures and the sentence previously read. From this the ability to spell was computed. If the patient failed in this test he was asked to copy ten single letters, seven figures, and the twenty-word sentence. If the disturbance was not gross, the simplest tests were sometimes omitted. In the end the patients were asked to copy the Stanford-Binet shapes from the mental age tests (form M) for nine and twelve years, and to perform the first five patterns of the Kohs' blocks test, in order to estimate visual and constructive ability. Finally they were given the serial seven test, and usually an abbreviated (halved) form of Raven's Matrices to test calculation and abstract thinking.

At some stage of the session a neurological examination was made.

The following (Case 1) is an example of the verbatim responses to direct questions and the vocabulary test. The patient, a trooper aged 22, had been a storekeeper and before his injury was fairly talkative. He was right-handed. Six months before his examination he had suffered severe concussion.

(What is the matter with your speech?) . . . Hm. To say names. (Is it that you can't remember them?) No—really. Hm. Sometimes yes; but I have no idea how the noise—no . . . (Do you mean the sound?) Yes, sound is foun—is formed. (Can you understand what is being said to you?) Oh yes. (How about reading?) Out loud? (Can you read to yourself?) Yes. (Are you slow, when you are reading to yourself?) (Slower than you used to be?) Yes, but not, so much. (How is your writing?) Writing I have to think of every word. I—it—takes—me—about one hour to do—a—write—a—pace—page—page.

BINET VOCABULARY ORAL

<i>Word</i>	<i>Answer</i>
Orange :	Something to eat.
Envelope :	To h—hold—something—in—to say the letter.
Straw :	Soming which—in—the Army—is—used —to—make—a—bed.

- Puddle : Water. (Where ?) In the gra—no—on the—ground.
- Tap : Cap—t—tap—a for—leg—a for—tis—em—to turn— (What ?) Water.
- Gown : Gown—a piece of cloth—usually made—made—em—u—use—used by women sometimes.
- Eye-lash : Eye—lash—em—(points to his own) To keep—something—dust and things, like that—out—of the—eye.
- Roar : War—roar—a tank roars—a tank wars, yes.

READ FROM PRINT

- Scorch : Scour — scorch, scorch — to — burn — nearly burn—something—to nearly, nearly burn something.
- Muzzle : Muzzle — mustle — mm — mustle—sometimes, when dogs go—sometimes —when dogs—are—too—fierce—they —are—put—on—a—muzzle.
- Haste : Haste—he—was—in a—haste—no—yes.
- Lecture : Lecshure — lecture — the — lecture — supposing — you — tell — I'm — me —no—supposing that—I was—to done do something wrong you would—lecture me.
- Mars : Mars—Mars ?—Mars—a—planet.
- Skill : Still—skill—still—skill—skill—he had he had a neck—neck—no—he was—very clever.
- Juggler : Juggler—jug—juggler—you can see jugglers—at—any fair.
- Peculiarity : Per—per—I can't—even—see it—em—em—the—thee—the.

The number of errors, or time needed in the various tests, was as follows :

1. Spontaneous word production (animals) : cat, god, goldfic-, goldfish, hem, toad, snake, pig, sheep, cow, bull, mmm— .. 9 in 1 minute
2. Binet vocabulary : 1-8 orally .. 8 correct
9-16 reading .. 7 correct
3. Naming 10 pictures or objects .. all correct
4. Showing 10 objects when names are given .. all correct
Showing 10 objects when names are given in print .. all correct
5. Reading monosyllables in 1 minute .. 34 out of 40 correct
6. Reading 7 figures : 6, ah 5, 8, 3, 29, 4-7, 615, 8372 .. all 7 correct
7. Reading 1 sentence (20 words) : "look—if you look back on your own—in—ed—u—ed—cru—ed—ce—edcru—ed—education" ..
8. Dictation : 10 words .. 4 mistakes
sentence (20 words) .. not attempted
7 figures (516 after many trials) .. all correct
9. Copying : 10 letters .. not done
20 word sentence .. no mistakes
7 figures .. not done
3 simple shapes .. no mistakes
10. Kohs' blocks : I .. 6 seconds
II .. 12 seconds
III .. 30 seconds
IV .. 15 seconds
V .. 15 seconds

11. 100-7 test : 93, 86, 79, 72, 65, 58, 51, 44, 35, no 37, 30, 23, 16, 9, 2 ... 3 minutes, no mistakes
12. Raven's matrices (abbreviated) .. not done

Fig. 1 shows this patient's "aphasia chart," which is an attempt at a graphic display of the disabilities. These charts are not mathematically accurate, which cannot be expected in work of this kind. However, in the study of aphasia it is imperative to assess the relative preponderance of one feature of the disorder over another, and this method of grading was, therefore, found helpful. In the absence of any one aspect of the disturbance the mark "O" was given; if doubtful it was charted under "1," if slight under "2"; moderate "3," marked "4," and if extreme "5." Both physical and mental features were included, and were so arranged that what commonly are called "motor" disturbances of speech were grouped with neurological motor disorders, and signs of "sensory" aphasia with defects of visual fields, posture sense, etc.

Each brain lesion was charted after careful consideration of the bone defect under the scalp, the skiagrams, the motor, sensory, and perimetric evidence of cortical damage, and the surgeon's report. In the absence of autopsies all these data could give but an approximate estimation of the site and extent of the cortical lesions. In view of the variability both in the size of skulls and brains, and in their mutual relationships, accurate measurements of distances from the edges of the bone defect to certain standard points on the skull were no help. The surface marking thus recorded often included damage in the depth of the hemisphere, where fibres had been destroyed, though their origin in the cortex may have escaped injury. Thus, tracks leading from the wound of entry and also buried foreign bodies were mapped on the chart.

In the "cumulative charts" (Figs. 2 to 11) the outlines of the brain wounds were superimposed. Each diagram assembles all those patients in whom one feature of speech was disordered to at least a moderate degree. These charts give an idea of the relative frequency with which an abnormal clinical characteristic was associated with a certain cortical area. Fig. 12 summarizes the results. In it the cases are arranged in topographical order and plotted against the graduated assessment of their disabilities.

Findings

Disturbances of Articulation, Inflection, and Speed.—The disturbances were marked in 20 out of 41 cases. In all but 2 these disorders occurred together.

One of the exceptions (Case 5) had very little speech disturbance, and his diminished speed was probably due to difficulty in word finding; the other (Case 32) spoke at a normal speed despite a definite disturbance of articulation and inflection. All 20 had some difficulty in word finding. Neurologically all but the one with very slight aphasia (Case 5) had some definite motor loss in the limbs; in 12 there was complete or almost complete uselessness of the dominant hand; 14 had marked loss

APHASIA CHART

No. : 6405115 ; Rank : Trooper ; Age : 22 ; Previous occupation : storekeeper ; Previous personality : fairly talkative ; Handedness : right ; Days after wounding : 6 months.

Surgeon's Notes : Severe concussion. Initial jargon. Cerebral protrusion. Cavity 11 cm. in length, 3 cm. wide, 3 to 4 cm. deep, involving lateral ventricle.

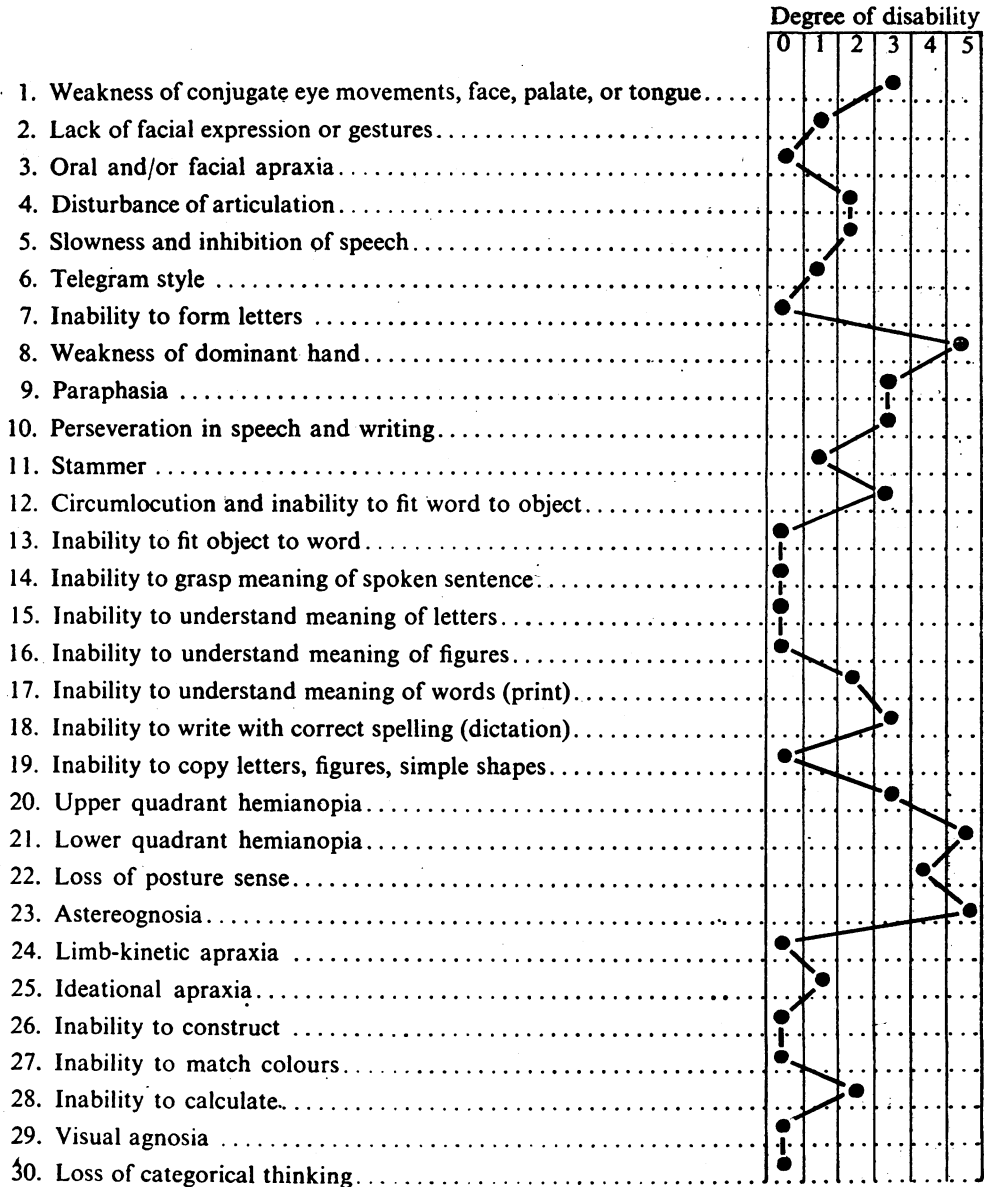
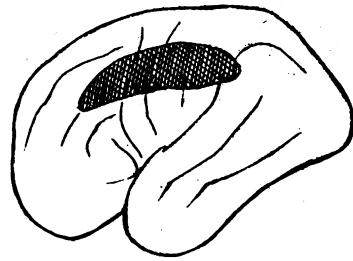


FIG. 1.

of postural sense with or without astereognosis; in 7 there was marked impairment of the right homonymous visual fields. Twelve had difficulty in using their lips and tongue for blowing, licking, and whistling ("oral apraxia"). This last phenomenon was seen only in patients with predominant disorders of inflection, articulation, and speed (Fig. 2).

Paraphasia.—In contrast to dysarthria the incorrectness of the paraphasic utterance is characterized not so much by indistinctness of pronunciation as by severe distortions of the phonetic pattern, by wholesale substitution of some sounds or sound-complexes, and by omissions. The result often bears only a faint resemblance to the intended word. There seems to be a scale in the severity of the word distortion, possibly indicating different physiological nervous levels. At one end is dysarthria, at the other complete substitution of the correct by an utterly incorrect expression (jargon). Slight distortions were "cotch" for "Scorch," "pa-aste" for "haste," "n-j-ogger" for "juggler," "occasial" for "occasional"; severe ones "toaster" for "postman," "gillery" for "juggler," "predger streamer" for "ship" ("pleasure steamer"). A frequent characteristic, especially in the stage of recovery, was the patient's dissatisfaction with what he was uttering, and his attempts at improving on it ("gillery, no, juggery, no . . ."); involuntary perseveration may play its part, as well as voluntary effort.

The 11 patients with definite paraphasia had some degree of defective auditory comprehension. There was also difficulty in word-finding, and a severe disorder of spelling (paragraphia). All but one had well marked "alexia"; they not only misread words (paralexia) owing to paraphasic slips, but their understanding of the text was poor.

Six (group A) had loss of articulation, inflection, and speed. These were the patients who neurologically showed pronounced motor and sensory loss; 4 of these had marked field defects and 3 marked oral apraxia. The 6 patients already quoted in the previous section had extensive rolando-parietal or rolando-temporal wounds (Fig. 3).

Conversely, none of the remaining 5 patients (group B) had any motor loss, and only 2 had a moderate disturbance of postural sense. Four had marked field defects. None had oral apraxia. The sites of their injuries were temporo-parietal. Fig. 3 shows these two groups.

Jargon.—In this disorder the words uttered by the patient have no meaning for the listener. This is the most severe type of word distortion, being allied to paraphasia but also associated with difficulty in word-finding and understanding, with inability to construct grammatical sentences, and with perseveration. Head (1926, p. 305) rather artificially relegated cases of jargon to his group of "syntactical" aphasia.

One patient (Case 40) defined "lecture": "Neck-exo-ext-exer—but ex-ex—well I can't say it is a nexer by a certain person to a so—odd—wot." And the word "peculiarity": "Ee picoahy—to a luddy." "Envelope": "I know it ees baw I do I know it is do tickle, uful. Too diffit." This kind of disorder was found in 5 of those cases included in the previous group of paraphasic manifestations. In no case of jargon was there any logorrhœa, that uninhibited flow of unintelligible words which usually accompanies jargon. Variations in temperament may influence the extent of logorrhœa, but its absence in our cases was striking. Guttmann (1942) noted absence of jargon in aphasic children. Jargon notoriously occurs with temporal-lobe lesions; all our cases with jargon had temporal-lobe lesions, but only half with temporal-lobe lesions showed jargon. In all these the damage was extensive.

Syntactical Errors and Telegram Style.—It seemed that "Style Nègre," as the French authors call it on account of its "pidgin" character, should be treated as a sub-group of disorders of grammatical structure.

Questioned about his speech trouble one patient (Case 45) said tersely: "Speaking. Not thinking." Case 32 said, "Juggler as a man do tricks"; and Case 26, "Juggler—two things mixed up." Examples of jumbled grammar are: "Lecture—well on gas anything to do with the Army one lectures," and (Case 32), "Gown is a thing on a morning and up on a bed." All these cases, too, had pronounced difficulty in word finding.

There were 19 patients showing some degree of agrammatism, including 2 whose expressive power was minimal. Only 3 had a fairly pure form of telegraphic style, their propositions being otherwise correctly constructed. Their injuries were mainly frontal. In 3 patients there was a tendency towards telegraphmatism with a more marked breakdown of syntax; 2 of these had only a mild degree of disturbed speech, articulation, and inflection; in 11 this was marked. In 11 patients some defective comprehension of language was associated with syntactical errors. Only 4, including those showing telegraphmatism in its purer form, had little or no trouble with their spelling; these all had mainly frontal injuries.

Neurologically 14 had marked motor, and 13 marked sensory disturbances; 9 had visual field defects, with pronounced difficulty in writing; 10 had oral apraxia.

The fact that agrammatism may be associated with signs of disturbance both of the afferent and efferent systems, that is, with pre-rolandic as well as post-rolandic injury, is shown in Fig. 4.

Perseveration and Stammer.—In perseveration and stammer the characteristic feature is repetition.

As an example Case 46 may be quoted: "Mars, Mars, it's a, it's a, oh, is a god of war"; or the same patient defining "straw": "Dried 'ey; no it isn't; it is the wheat, ah . . . it's the thrust and—th . . . th . . . the, the thorn"; or defining "puddle": "Puddle? Water? Puddle is wa-water, gets, no, a w-water, dried, no, a dried, sticky, no, a puddle." Here we have

DISTURBANCE OF ARTICULATION,
INFLECTION, SPEED

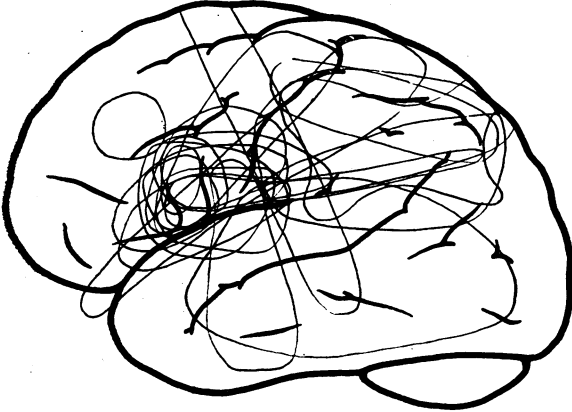


FIG. 2.—The wound contours converge to, and form the greatest density in, the foot of the precentral convolution and in the posterior end of the 3rd frontal convolution. There are only two exceptions (Cases 13 and 46) where there were parieto-rolandic lesions. Case 13 had a large gutter wound tearing the sagittal sinus, resulting in complete paralysis of the right upper limb and marked facial palsy; one patient (Case 46) had a spinal fluid leakage and fungus cerebri with a similar neurological picture. It is therefore probable that in these two cases also the brain damage extended to the area where most of the wounds centred. (20 cases: Nos. 2, 5, 6, 7, 11, 13, 14, 21, 28, 32, 33, 35, 36, 37, 38, 40, 42, 44, 45, 46.)

PARAPHASIA

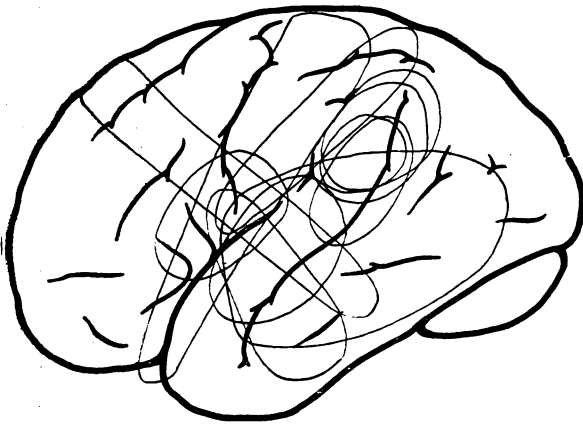


FIG. 3.—There are two areas with overlapping outlines. One (Group A) is fronto-temporal and is formed by widespread injuries; it corresponds to patients with loss of articulation, inflection, and speed. The other (Group B) consists of relatively small wounds clustered round the hind end of the Sylvian fissure; in this group there was no motor loss and no loss of articulation, etc., but marked field defects. (11 cases: Nos. 6, 10, 14, 15, 26, 30, 31, 38, 40, 42, 44.)

DISTURBANCE OF SYNTAX AND
TELEGRAM STYLE

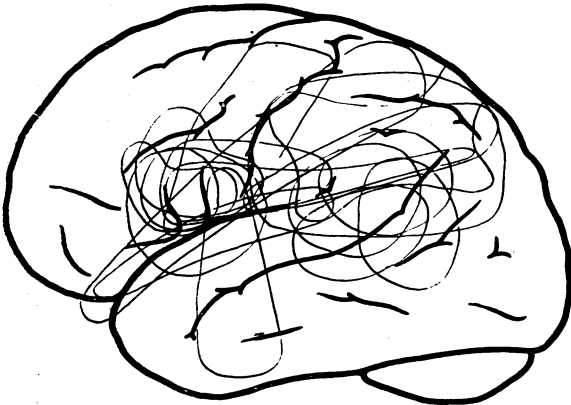


FIG. 4.—A fronto-temporal cluster of wounds producing telegram style and defects of tonality, rhythm, and speed. Another temporo-parietal cluster is from patients with gross disturbance of sentence and word patterns, and defective understanding, reading, and writing. (17 cases: Nos. 2, 3, 10, 11, 13, 14, 26, 30, 32, 33, 35, 36, 38, 41, 42, 44, 45.)

repetition of words, of syllables, and of initial sounds in a patient labouring to find, form, and pronounce the suitable word, being dissatisfied with the result, trying again, and at times finding himself thrown back to the starting-point. It is difficult to decide whether he is persevering in his task, or is the victim of involuntary perseveration, or both. Another example of distressing perseveration was Case 38: "I can put my name down, K.S.P., and I can't put it down, police, and I thought I can't put it down, police, police, police, well it's hopeless."

Of the 14 cases in which perseveration was well developed, 2 had marked stammer but no other features to distinguish them from the rest of the group, which was characterized by predominantly "expressive" disturbances, and by marked difficulties in word finding and spelling. Twelve had the striking characteristic of severe sensori-motor hemiplegia; 7 had marked hemianopic field defects, most of them mainly in the lower quadrant. The parietal and parieto-rolandic regions were conspicuously affected in all but 1 case (Fig. 5).

Auditory Incomprehension.—The study of comprehension of speech is more complex and less reliable than that of expression. We can observe an individual's response, but have no direct insight into how much he is taking in, and in what way. The severity of incomprehension was relatively less striking than the severity of expressive disorder in comparable groups of cases. Naturally it is easier to fit an object to a name than a name to an object. Although almost complete speechlessness was sometimes encountered, a similar degree of incomprehension was never observed, but all these cases were recovering or had recovered from the acute stage of injury, during which some of them may have had complete auditory incomprehension. The patients were rarely aware of "Speech-deafness"; only one (Case 41) had the insight to say: "In a way, some of them, I can't hear them."

The ability to point to objects or pictures named by the examiner is the simplest test for the understanding of words. None of the 24 patients in this group made mistakes in performing it. A word given with a limited number of pictures exposed facilitates the correct association. These patients failed, however, to understand long, unexpected, and less common words, or to respond to oral commands. This failure was more noticeable when the task involved two or three concepts, such as "the hand" and "the mouth," or "to point" and "the window." Often it was necessary to slow down or repeat a command. Sometimes the patient would repeat it to himself before grasping its meaning and carrying it out, but this is, of course, only an exaggeration of the normal process in such situations.

Sentence-repetition cannot be uniformly tested since it involves variable factors: firstly it is possible to repeat word sounds without grasping their meaning; secondly there is the factor of memory, inherent also in the execution of longer oral commands, and thirdly,

there may be disturbance of the speech function concerned with the mobilization and formation of words.

Half the patients with disturbed auditory comprehension, including 3 of the most severe, had predominant difficulties of expression; all 12 had very extensive wounds, manifested by gross loss of power and sensibility of the dominant hand (Fig. 6). Among our 20 patients with gross expressive disturbances (described under "Disturbances of articulation, inflection, and speed") only 3 had little or no auditory incomprehension, and of these one had a history of auditory incomprehension at an earlier stage, soon after wounding.

In the other 12 cases there was auditory incomprehension without difficulties of expression or weakness of the dominant hand. In these the lesion was in the temporo-parietal region. All had difficulty in word finding.

Disability to grasp visual symbols of speech (reading defects) was found in 18 of these 24 cases. Fifteen had gross hemianopic field defects.

Reading.—In silent reading the relevant mechanisms consist of the appreciation of visual symbols and of their association with meaningful words, which must be easy of access. In reading aloud patients with articulatory disturbances have the additional difficulty of expression. In the more severe type of disability the energy spent on integrating the word patterns leaves the patient with no reserve for appreciating their meaning (Pick, 1913).

On the other hand, the opposite difficulty was observed: "I get the meaning, but I can't read it out," explained Case 15 who had no disorder of articulation, inflection, or speed. One patient (Case 11) would easily find objects, when their names were given to him in print, and would execute written orders to some extent; yet, when reading aloud he would take in the print at a glance, then shut his eyes and so apparently concentrate hard on trying to find the sound or kinæsthetic pattern for the word, the graphic symbol of which had conveyed to him its meaning. Another type of patient, who showed that he had grasped the meaning correctly, would nevertheless promptly translate the printed word incorrectly or by a synonym, for example, "for" instead of "of," "when" instead of "if," or "father" instead of "foster-parent."

Many patients, losing the mental track of the sentence and possibly handicapped by hemianopia, tend to omit words. On the other hand where the reader's appreciation of the meaning is guided by the context, his performance gains in efficiency and he may fill in by guessing what he fails to read.

Paraphasia and jargon complicate the picture of a reading disability ("paralexia"); as when a patient reads "gone back" for "look back," or "four enkerchief" for "your own education" (Case 14). Spelling the words aloud was sometimes found to help (Case 38). Extreme slowness in reading, without "paralexia," and in the absence of slowness of speech, was seen in Case 20, who took 45 seconds to read the twenty-word sentence, but without a mistake. This patient also took

PERSEVERATION AND STAMMER

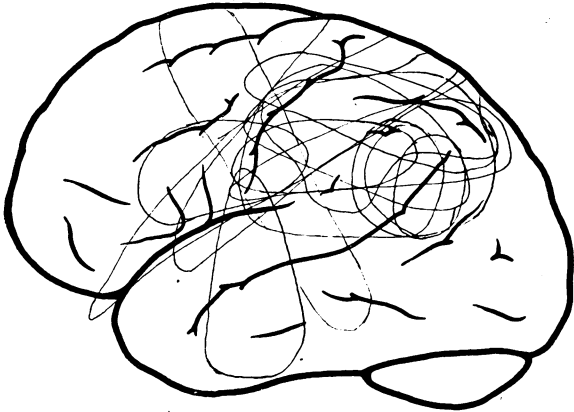


FIG. 5.—All lesions, with the possible exception of one, affect the parietal lobe. (14 cases : Nos. 1, 2, 3, 9, 13, 25, 26, 33, 35, 38, 40, 42, 44, 46.)

DISTURBANCE OF AUDITORY COMPREHENSION

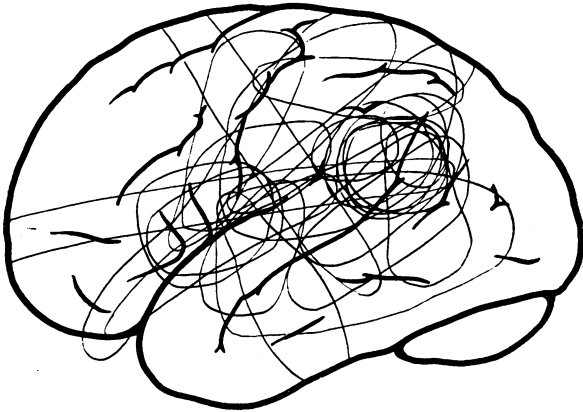


FIG. 6.—One cluster in the fronto-temporal region, of patients with associated gross expressive shortcomings. Another cluster, of smaller wounds, in the temporo-parietal region, corresponds to cases showing more isolated auditory incomprehension. (24 cases : Nos. 3, 6, 9, 10, 11, 12, 14, 15, 19, 20, 21, 23, 26, 29, 30, 31, 33, 35, 38, 40, 41, 42, 44, 46.)

DISTURBANCE OF VISUAL COMPREHENSION (READING)

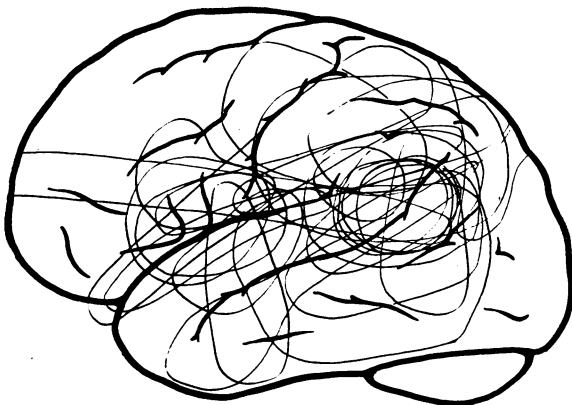


FIG. 7.—Greatest density of wounds in the temporo-parietal region. Three of the five wounds not extending into this area and probably purely fronto-temporal gave rise to no associated auditory incomprehension. (25 cases : Nos. 1, 2, 3, 6, 10, 11, 12, 14, 15, 19, 20, 21, 22, 23, 26, 27, 29, 30, 31, 32, 38, 39, 41, 42, 44.)

a long time before he, again correctly, identified the ten pictures of the test series when their names were given to him in print.

In some cases with dysarthria and paraphasia, however, reading aloud was better than spontaneous speech; here the visual word pattern served as an aid to word formation. Single numbers were read better than letters—a reflection on the fact that children usually learn numbers before learning the alphabet.

The 25 cases in this group had difficulty in word finding and in writing, as well as disturbed reading. Twenty showed considerable auditory incomprehension. Only 2 patients had no hemianopia. Sixteen had dysarthria, 4 severely. Motor loss was present in 11 cases, sensory loss in 15, field defects in 18 (Fig. 7).

Disturbance of Writing (Spelling).—Spontaneous writing was not tested, but only the grosser disturbances revealed by dictation.

Among our 46 cases there were only 7 (Fig. 8) who had no marked defect in spelling words such as "recommend," "business," "instruction," or "education." Of these, two (Cases 4 and 43) had small wounds, at the posterior superior end of the parietal lobe and at the tip of the temporal lobe respectively; there was no significant disturbance of speech. The remaining 5 (28, 35, 36, 40, 45) with intact spelling had frontal lesions; they had "expressive" shortcomings and difficulty in word finding, but two also had slight trouble in understanding the spoken word; in these the wounds extended into the parietal and temporal lobes. One of these (Case 35), though spelling correctly, displayed the same slowness in writing as in speaking; he took 7 minutes to write ten dictated words. In the other case (40) with a rolando-temporal lesion, spelling was better than vocal expression; he was extremely slow. Another, with apparently intact handwriting (Case 28), was equally slow; there remained 2 cases of normal spelling. A certain slowness, of course, has to be allowed for in a right-handed man whose right hand is paralysed so that he has to use his inexperienced left hand, but on the whole retardation was too gross to be accounted for by this handicap alone.

Nineteen out of these 39 bad spellers were selected on account of their outstanding defect. The spelling of a word was made easier for them, after they had failed, by the examiner's spelling out each letter. Six were unable even to write their own names, the easiest writing performance except for writing numbers. Nine had some difficulty even in copying letters and words. Case 15, an intelligent officer in perfect general health, would display a slight tendency towards mirror-writing in copying, using something like a Greek " μ " instead of a "y," " β " for "b," or the number 8 as a substitute for various letters. He would also write down four incoherent vowels, "a, i, e, u" in response to the dictated number five. This happened 15 days after he was wounded; 4 months later these particular features had disappeared but he was still dysgraphic. Another officer (Case 22), having a left parietal wound with unawareness of the right arm, was not only unable to copy letters, numbers, and simple shapes, but also failed in the simplest arith-

metic and the construction of Kohs' block patterns; he could not use his intact left hand and arm for waving and showing the movement of using a key, either spontaneously or by imitation. While understanding the command, he somewhat aggressively expressed disappointment with his failure. Referring to his inability to write with his left hand and refusing to admit his obvious apraxia he said: "I can't write at all because of my left hand, you see I'm right-handed, I've never been able to use my left hand," an excuse not encountered in any other patient.

Eighteen out of 19 had difficulty with reading; 15 a marked degree of hemianopia; 12 were poor in handling Kohs' blocks, and 10 in handling figures; 15 had some trouble in understanding speech; 9 disorders of articulation, inflection, and speed; 9 had marked motor, and 9 sensory loss in the dominant hand.

Fig. 9 shows the importance of the parietal lobe for writing; only 5 out of 19 cases had fronto-temporal lesions, but with extensive loss of brain substance.

Disturbed Ability to Construct.—Kohs' blocks test, for examining abstract thinking by calling upon the ability to analyze and handle relationships of space and colour was given as a non-verbal test, as such ability is often affected together with speech. Only gross failure in the absence of gross dementia, as assessed by the patient's general behaviour, was considered significant. Patients were given only the first five very simple patterns. No attempt was made to establish an upper performance level for those who undoubtedly would have done better.

There were 18 patients who, by their slowness or complete failure in some patterns, showed a performance level corresponding to a mental age from 12 down to 7 years, or an intelligence quotient ranging from 87 per cent. down to 49 per cent. All these, as one would expect, had abnormal difficulties in calculation and spelling, in addition to impaired word finding; 15 had definite reading disturbance, 13 impairment of auditory comprehension, 7 disorders of articulation, inflection, and speed. Fourteen had visual field defects, 13 sensory defects, and 11 loss of motor power of the dominant hand. All except one had wounds impinging on the parietal lobe, most of them in its posterior-inferior part (Fig. 10).

Disturbances in Simple Arithmetic.—These are related to aphasic shortcomings in at least two ways; firstly in that numbers themselves are symbols for concepts, and secondly in that their handling requires the integrity of general mental processes such as memory, visual and spatial imagery, and thinking in abstract categories. The performances may either be considerably slowed down (though yielding a correct result) or the result may be incorrect, or both. As slowness of expression is a natural handicap in presenting the results, this in itself was not made a criterion of failure, except where it was out of proportion to the speech defect.

NO SPELLING DEFECT

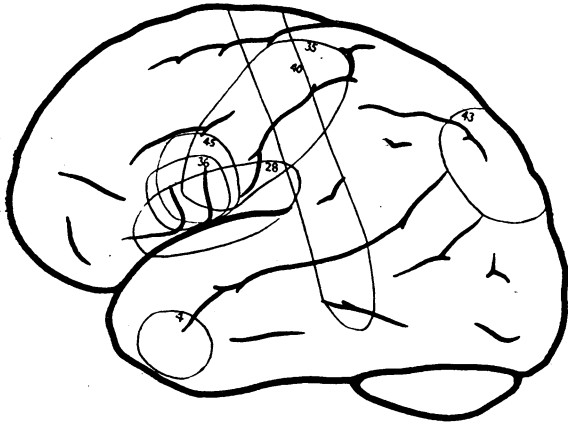


FIG. 8.—Four wounds affecting Broca's area. Two cases outside the greater speech area. One exterior temporo-rolandic wound. (7 cases: Nos. 4, 28, 35, 36, 40, 43, 45.)

MARKED SPELLING DEFECTS

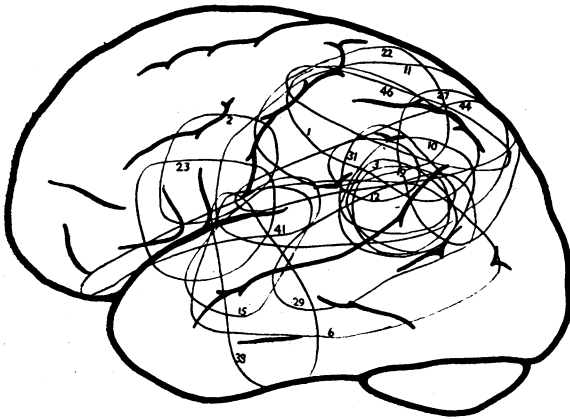


FIG. 9.—Note the predominant involvement of the parietal lobe. (18 cases: Nos. 1, 2, 3, 6, 10, 11, 12, 15, 19, 22, 23, 27, 29, 31, 38, 41, 44, 46.)

INABILITY TO CONSTRUCT
(KOHLS' BLOCKS TEST)

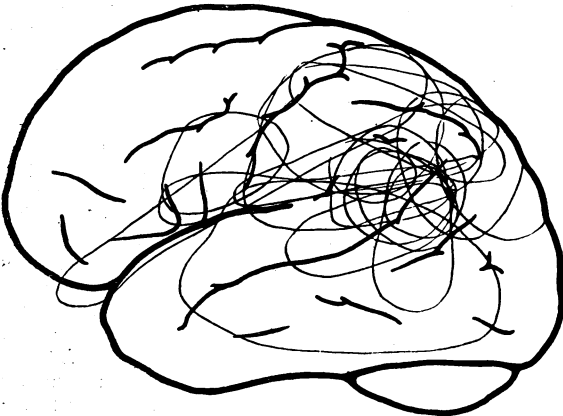


FIG. 10.—Note the predominant involvement of the parietal lobe. (18 cases: Nos. 2, 3, 6, 9, 11, 12, 16, 19, 20, 22, 27, 30, 31, 32, 42, 43, 44, 46.)

RAVEN'S MATRICES

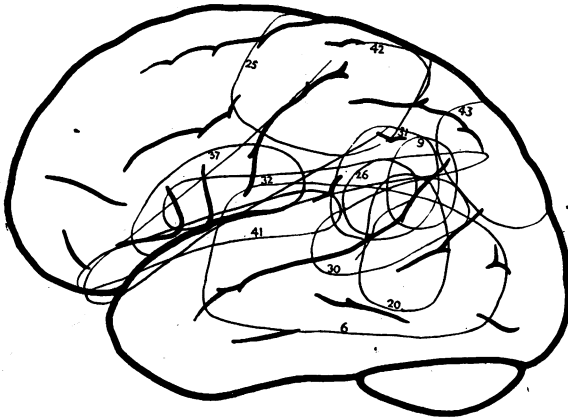


FIG. 11.—Wounds of patients whose score was in the under-25 per cent. group; some of them relatively small; most of them in the temporo-parietal region. (12 cases: Nos. 6, 9, 20, 25, 26, 30, 31, 32, 37, 41, 42, 43.)

Moreover when the patient is labouring with the task of relating figures to each other, his expression may suffer. The converse, when the difficulty in saying and finding words interferes with the process of calculating, is found even more often.

Some more intelligent patients were able to give the results in their own imperfect but correct way, by tapping or by saying: "Five-one" instead of "Fifty-one." In performing written sums characteristic mistakes were found, such as the failure to carry over or to treat a number according to its place in the decimal system. This may well be due to inability to keep in mind spatial and part-whole relationships. It also contains an element of perseveration. There were in all 24 cases, including the 18 already mentioned in the previous section.

Apraxia and Agnosia.—There was only one definite case of apraxia (Case 22), which has already been mentioned in association with a writing disability. No obvious case of pure visual agnosia was found.

Impairment of General Intelligence and Categorical or Abstract Thinking.—Twenty unselected cases were given Raven's Matrices, an intelligence test which, though apparently non-verbal, seems to require some internal verbalization.

Table

	Percentile groups							
	Under	5	10	25	50	75	90	95
No. of cases (total 20)	..	7	2	3	4	3	1	0
Intelligence	..	Below			Average		Above	
No of cases. (total 20)	..	12			7		1	

The Table shows that 35 per cent. (7 out of 20) were in the lowest percentile group, and the majority of cases, i.e., 12 (60 per cent.), below average. Only 4 or 5 out of the 12 had extensive brain wounds.

Two and a half months after being wounded one patient (Case 43) had no obvious remaining aphasia but scored badly with Kohs' blocks and the serial seven test. A printer and compositor in civilian life, he must have been of at least average intelligence. His wound was an upper parietal one. The rest of the cases with low intelligence scores had wounds and aphasic disturbances mainly of the parietal and parieto-temporal type (Fig. 11).

Left-Handers with Right Hemisphere Wounds.—The two cases encountered (17 and 34) were similar in most aspects. Left-handed without any such family history, they had both been taught to write with their left hand and used it as the dominant hand in their daily lives.

Case 17, aged 26, was a corporal, in civil life a clerk in a chemist's shop; Case 34, aged 25, a regular trooper. Neither had stammered in childhood. Case 17 had received a shallow laceration midway across the right rolandic area, probably extending into the temporal lobe, followed by unconsciousness (post traumatic amnesia for three weeks). He had never been definitely aphasic. When seen six months after being wounded he had a moderate left facial weakness, complete spastic paralysis of the left hand with complete loss of postural sense and astereognosis, and slight left upper and moderate left lower quadrantic homonymous hemianopia. He had no oral apraxia, and his spontaneous speech and his reading abilities were perfectly normal; but his difficulty in learning to write with his right hand was far in excess of right-handed persons who have to change over to the left hand. He wrote very slowly and in clumsy block letters which tended to increase in size towards the end of the words, and he spelt wrongly nine- and ten-letter words ("recommen"; "copngeous" for courageous). Moreover he was unable to carry out the serial seven test; he produced "83, 79, 72," and gave

up after a struggle lasting two minutes. He was tested with Kohs' blocks two months after his injury, when he was found unable to do even the simplest pattern.

Case 34 had a more extensive wound, three finger-breadths wide across the upper right fronto-rolando-parietal area, that is, away from the speech area. His injury had also resulted in complete paralysis of his left hand, with moderate loss of postural sense and fairly marked astereognosis but no hemianopia. When seen two and a half months after being wounded his expression and understanding of the spoken word, as well as his reading, were normal. But he, too, had disproportionate difficulty in learning to write with his right hand; his letters were too large and unwieldy, and some words of over seven letters were wrongly spelt. Moreover he made mistakes in carrying over when doing a sum; but made only one error in the serial seven test, for which he took eighty seconds. He was unable to perform one of the first five Kohs' blocks patterns.

Discussion of "Nominal" ("Amnesic") Aphasia.

—The term "nominal" aphasia is usually applied to a patient's failure to give a name to a thing. The term is derived from Head's classification, but its use is an over-simplification and distortion of the author's definition. This comprised not only the "loss of power to employ names," but also the loss of "*comprehension of the nominal value of words and other symbols,*" that is, not only the inability to fit a name to an object and an object to a name, but also a defective appreciation of written language and of numbers. The term "amnesic" aphasia first appeared in the French, then in the German and American literature to describe disturbed memory for words. "Logically," Weisenburg (1935) said, referring to patients with difficulty in evoking words as names for objects, "patients of this type belonged to the predominantly expressive group. Psychologically, however, their disorder was so different in nature that they could not well be classified with that group. Neither did they belong to the predominantly receptive group, for their understanding remained always relatively superior." A fourth group (the third was the mixed expressive-receptive) was, therefore, "created" and called amnesic. This term brings us back to Broca's "verbal amnesia," which included all speech disturbances that were not "aphemia," the latter being due to lesions of the third frontal convolution. Goldstein (1932) speaks of "central" aphasia, a term almost synonymous with "nominal" aphasia.

"Amnesic" or "nominal" aphasia in the current, popular sense of the word was found in all our patients according to their main shortcomings in either expression or understanding. Although it often seemed to be the predominant feature, it was never found as an isolated phenomenon.

Nominal aphasia, being an integral feature of any type of aphasia, is therefore the least helpful finding for localizing a lesion within the speech area.

There were, however, two patients (Cases 16 and 43), right-handers with left hemisphere lesions both in the upper parietal region, who at the time of examination—two and a half and ten months respectively after being wounded—showed no signs of nominal or other type of disordered speech. Case 16 had also a right parietal intracerebral clot. These cases were included in our series because they displayed defective calculation, construction, and spelling, with a residual weakness of the right hand and field defects. Case 43 was reported to have shown earlier a "nominal aphasia and alexia."

General Discussion

Wilson (1920) and Weisenburg (1935) objected to the choice of brain injuries for this type of inquiry because of the generalized effects of concussion and of other widespread or multiple damage. The advantage of studying traumatic cases, however, is that they present circumscribed lesions and can be examined during convalescence. There is a less generalized disturbance of brain function than in cases with raised intracranial pressure or vascular disease.

Although subordinate to the effects of focal brain injury, several other factors seemed to influence the clinical picture. These may be divided into (a) personal and pretraumatic factors, and (b) those due to trauma.

Personal and Pretraumatic Factors.—These include heredity, mental age, the preponderance of a visual or acoustic type of memory, the level of education, trends of personality, and pre-existing speech disturbances.

Factors due to Trauma.—These may themselves be subdivided into general and local factors.

GENERAL FACTORS

(a) *The Time Factor.*—The more recent the injury the more severe and global were the aphasic features. This was probably due to traumatic effect on large areas surrounding the lesion, these being put out of action by "concussion" or oedema. In a normally healing wound recovery from aphasia was rapid within the first month or two. Thence the speech disorder maintained its characteristic pattern, but usually decreased in severity. The pathology and extent of the lesion determined the degree of recovery.

(b) *The Bulk of the Tissue Destroyed.*—The ultimate clinical effect of a large injury and the immediate effect of a small injury are comparable. Small wounds bordering on, but not directly affecting the speech area (Cases 16, 43) may cause

little disturbance once the adjacent regions concerned with speech have recovered from the transient initial damage.

In order to separate the effects of massive destruction of brain matter verging on the classical "speech centres," from lesions around the Sylvian fissure, we should distinguish between "global" and "total" aphasia, that is, between the range of abnormal manifestations, and their severity or degree. A patient with "global" or "mixed" aphasia is one who shows some disorder which may be mild, but affects all or most aspects of speech; a "total" aphasic is one whose global aphasia is of such a degree that he has lost almost all normal means of social intercourse. Such a patient will, in fact, be demented as well as speechless.

Although it was difficult to assess the volume of brain tissue lost or permanently put out of action, the 13 cases with very large wounds did in fact show the greatest collection of individual disorders of speech (1, 2, 6, 11, 13, 23, 26, 32, 38, 40, 42, 44, 46).

A very large wound bordering on, but not directly affecting the left perisylvian area may cause moderate global aphasia (44, 46). The mere volume of dominant hemisphere tissue destroyed, irrespective of its localization, will, therefore, influence the degree of speech and intelligence less, but local factors dominate in determining the type of aphasia.

LOCAL FACTORS.—Fig. 12 has been compiled from the individual charts of each case. It is supplementary to, and a summary of, the cumulative charts. In this table the localization of each brain lesion is correlated with all the symptoms displayed by the case. The list of cases starts with frontal lesions (F), followed by lesions situated further backward along the Sylvian fissure, first above it (F.R.), then including the temporal lobe (F.R.T.), etc. The severity of each feature is expressed in quarter squares, according to the degree of disturbance, as plotted from 2 (slight) to 5 (extreme) on the individual charts (Fig. 1). "General factors," in particular the bulk of tissue destroyed, have had a considerable influence in shaping the aspect of the table, e.g., in Case 6 who had a lesion affecting T.R.P.O. (Temporo-rolando-parieto-occipital).

LOCALIZATION	ARTICULATION	INFLECTION	BRADYPHASIA	PARAPHASIA	JARGON	TELEGRAM	SYNTAX	PERSEVERATION	NOMINAL	AUDITORY COMPREHENSION	VISUAL COMPREHENSION	SPELLING	CONSTRUCTION	CALCULATION	APRAXIA
F	5														
F.R.	7														
	36							?							
	45														
F.R.P.	2														
	32														
	35														
	37														
	46							?	?						
	21														
F.R.T.	23			?	?			?							
	40														
	14														
	28														
P.R.	11														
	13														
	33														
	44														?
	1														
	25														
	22														
	16														
F.T.	41														
T.R.	38														
T.R.P.	42														?
T.P.	9														
	26														
	15														
	39														
T.P.O.	10														?
	19														
	31														
T.R.P.O.	6														?
T.P.O.	3														
T.O.	20														
	29														
	30														
P.	43														
P.O.	12														
	27														
O.	24														

FIG. 12.—Summary of results shown in "cumulative charts." F=frontal; F.R.=fronto-rolandic; F.R.P.=fronto-rolando-parietal; F.R.T.=fronto-rolando-temporal; P.R.=parieto-rolandic; F.T.=fronto-temporal; T.R.=temporo-rolandic; T.R.P.=temporo-rolando-parietal; T.P.=temporo-parietal; T.P.O.=temporo-parieto-occipital; T.O.=temporo-occipital; P.=parietal; P.O.=parieto-occipital; O.=occipital.

Three outstanding points may be noted :

1. More than one aspect of speech is affected in each case.

2. "Nominal" aphasia is present in almost all cases, wherever the wound.

3. Disorders to the left of the chart give place to those on the right as the site of wounding becomes more posterior.

In a more detailed study of the cases the following points on localization emerge :

(a) *Frontal Lesions*.—Wounds affecting the lower part of the precentral area produce disturbances in articulation, inflection, and speed. Poverty of speech, laziness, and telegraphic style are common. It is irrelevant whether such terms as "anarthria" (Marie), "motor" (Wernicke), "verbal" (Head), "expressive" (Pick), or "Broca's" aphasia are used for their designation. Word finding is also impaired in these cases, and there may be repercussions on other aspects of speech.

(b) *Temporal Lesions*.—The more a lesion encroaches on the temporal lobe, the more impaired is the auditory control of what the patient says and his understanding of word sounds. Auditory control implies that auditory schemata regulate the speech act, and influence the shape of words and phrases supplied from, or identified by memory.

The nearer to the frontal lobe a temporal lesion is situated, the more will the disturbed performance be tinged with "frontal" characteristics. Telegraphic style will be prominent, together with other syntactical shortcomings. Paraphasia and jargon are the outcome of most lesions of the first temporal convolution ; but when the former are present the parietal lobe is also usually affected.

The further back the lesion in the first temporal convolution, the greater is the disturbance of reading and writing, in addition to auditory incomprehension.

(c) *Parietal Lesions*.—All aspects of speech related to orientation in space are affected in parietal lesions. Writing and spelling, being a translation of words into symbols of shape and space will be grossly impaired ; also reading and calculating, and the ability to construct. Perseveration with or without stammer is common, especially with large wounds, and word schemata are particularly difficult of access. In fronto-parietal lesions there appears to be a characteristic hold-up between the acts of recalling a word, and translating it into a sound and kinesthetic pattern, ready for the final vocal delivery. The more widespread the lesion, and the further back and up along the slant

of the Sylvian fissure, the more pronounced is the patient's intellectual loss.

One will agree with Jackson (1932), Pick (1913), Head (1926), and Goldstein (1932, 1942), that an aphasic is essentially an individual struggling to readapt himself to the havoc wrought in those parts of the dominant hemisphere which surround the Sylvian fissure. The abnormal features of such a patient elude precise terminology. Dysarthria in its most severe form may be indistinguishable from paraphasia ; paraphasia in its highest degree may be called jargon. In the telegraphic type syntactical errors are allied to purely expressive disorders ; on the other hand auditory incomprehension may be responsible for some manifestations of agrammatism. Perseveration plays its part in both "expressive" and "receptive" disturbances, efferent and afferent impulses interacting to impede one another.

There seem to be two allied reasons why aphasia should be mixed—its composition varying with each individual : one is the close functional interconnexion of cortical areas whose damage leads to disorganization of speech ; the other lies in the very nature and evolution of speech, which is not merely a system of symbols to convey ideas and emotions, but has been primarily developed as an instrument for man's action and intercourse in society. As such it is firstly an aid to the tactile organs, mainly the dominant hand. We speak in order to attract and repulse, to get things, and get things done for us. Secondly, an object known by its name, a relationship grasped through a phrase, help with their perception. Percepts are differentiated and intensified by words which facilitate memory processes. Thus the interplay of action, perception, and memory is enhanced by speech, and diminished by its disorders. This relationship of language to the main functions of the central nervous system is mirrored in the topography of the speech area in the cerebral cortex.

In trying to classify pathological phenomena of speech we have first to distinguish and then to correlate three different approaches to the aphasic patient, each approach implying a different set of data and terms. First, we describe the recorded products of disturbed speech in terms of phonetics (e.g., dysarthria) and linguistics (e.g., paraphasia or agrammatism). Secondly, we interpret the act of speaking in physiological and psychological terms (e.g., motor, or amnesic). Thirdly, we have a verifiable lesion in the brain which is qualified anatomically. It is the correlation of these three sets of terms which so complicates the final classification of aphasia, and only our anatomical findings are strictly capable of isolation, definition, and

measurement. We are reminded of Goldstein's (1942) warning: "We must first know *what* we have to localize." Should we then agree with Head (1926) that it is "of no use trying to localize the position of an unknown function on the surface of the brain" and with Weisenburg that "localization of language and its disturbances is impossible"? Since none of our patients with aphasia was free from difficulties in word finding, can we accept Marie's distinction into "anarthria," a purely physical phenomenon, and "aphasia," a purely mental one? Or, on the other hand, should we adopt Kinnier Wilson's (1920) attitude (based on Liepmann (1908)) that "motor aphasia is but a part of apraxia and sensory aphasia of agnosia," knowing that none of these four qualifications covers the facts observed by us? In the light of our findings such resignation seems not altogether justified.

Despite the assumption that "symbolic formulation and expression are integrated on a level superior to that of motion and are of a higher order than sight and hearing" (Head, 1926) we believe that disorders of speech are closely allied to the known functions of the cerebral cortex. Head also stated that "there were no such things as 'types' of aphasia," but went on to set up his four loose groups of "verbal," "nominal," "syntactical," and "semantic" aphasia, linguistic terms which have not been widely accepted as they are neither self-explanatory nor practical nor natural. Yet aphasic manifestations tend to fall into groups according to the predominant features. Weisenburg's (1935) terminology (based on Pick's) distinguishes, in functional terms, between "expressive," "receptive," and "amnesic" types. Although this is convenient, it does as little justice to the majority of cases as did the old distinction between "motor" and "sensory" aphasia, and our findings do not justify the separation of an "amnesic" group.

Thus, all attempts to classify aphasia according to the type of functional disorder have proved disappointing. Yet a practical classification is required to indicate the part of the brain affected in any aphasic patient. "Diagram-making" has been rightly scorned by Head, and we are well advised not to regard the cortex as a mosaic. But our findings imply association of a certain mixture of symptoms with some approximate area in the brain. This area is roughly predictable after careful estimation of the patient's responses to a wide range of psychological tests, and grading of the results in order of their predominance. Instead of the unsatisfactory classifications in functional terms, we might then refer to frontal, fronto-temporal, temporo-parietal, and fronto-parietal

types of aphasia. Although we cannot achieve the relative accuracy of localization which obtains at lower levels of cerebral integration, we feel justified in using those broad and simple anatomical terms.

Summary

1. In an attempt to elucidate and simplify the problems of terminology, classification, and cerebral localization of aphasia, 46 war casualties with penetrating missile wounds of the dominant hemisphere and some disorder related to speech function were examined.

2. These men were subjected to 20 standardized tests, most of them short and simple, including abbreviated forms of vocabulary, Kohs' blocks, and Raven's matrices tests.

3. The results were plotted on graphs, by giving "marks" ranging from 0 to 5, in order to chart the relative degree of disturbance in each aspect of speech.

4. Cumulative diagrams representing the surface of the dominant hemisphere were used, on which were mapped out, in their approximate size and site, the brain wounds of each patient displaying any particular aphasic feature. The area of greatest density produced by these superimposed wound contours was thus interpreted as the area most commonly affected in patients suffering from that particular aspect of aphasia.

5. The analysis of the findings confirmed the mixed nature of most aphasic disorders, their ill-defined and transitional character, and their relative dependence on personal and other pretraumatic factors.

6. In all cases with true aphasia there was difficulty in word finding ("nominal" aphasia), regardless of the site of the lesion within the "speech area." This essential feature is, therefore, considered the least valuable for localization. Spelling was likewise affected in all but 7 cases.

7. Follow-up studies showed that the earlier pattern of the speech disorder persists, though great improvement in the degree of disability occurs.

8. The grading of the severity and the relative prominence of each feature was considered important, but no rigid dichotomy into afferent and efferent types of disorder could be established.

9. Frontal lesions tended to impair most the speaker's initiative, the speed of his enunciation, the articulation of his words, and the inflection of his voice.

10. Temporal lesions hampered the understanding of spoken language, both of what the patient was saying and what was said to him. The structure

and interpretation of words and sentences suffered (paraphasia, jargon, and agrammatism) by the loss of auditory control on a high level.

11. Posterior-temporal and temporo-parietal lesions interfered mainly with the interpretation of visual symbols of speech (reading and writing).

12. Parietal lesions in particular caused a disturbance of all those faculties related to orientation in space and appreciation of shape; the pattern of the word or proposition to be said, read, or written became distorted. Stammer and perseveration were also common.

13. Lesions of the posterior part of the Sylvian area were the most deleterious to the more highly organized intellectual aspects of speech function.

14. The bulk of brain tissue destroyed was proportional to the severity and extent of the disorder involving both speech and intelligence.

15. Two left-handed patients with trans-rolandic right hemisphere wounds had difficulty not with speaking, but with writing, counting, and constructing.

16. The application of a set of tests and a graph for grading of severity, as outlined above, may make it possible to pick out the salient features of any given case of aphasia in about one hour. The judicious analysis of such a mixture of signs

will then outline the responsible lesion in the various combinations of frontal, temporal, and parietal areas. For the sake of expediency it is therefore suggested that cases of aphasia should be classified in anatomical and not in functional terms.

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