

THE MENTAL SYMPTOMS OF CEREBRAL TUMOUR.¹

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THE older writers upon the mental symptoms of tumour of the brain made various estimates of their relative frequency. Andral [1] in 43 cases, and Durand-Fardel [8] in 70 cases, found that such symptoms were very rare, and thought that they should be regarded as exceptional. Nasse [20], however, found mental symptoms in 19 out of 50 cases, Friedreich [9] in 19 out of 44, and Lebert [17] in 29 out of 90, while Ladame [16], in 1865, noted them in 112 out of 331 collected cases—a proportion of from one-third to two-fifths. Calmeil made the curious observation that, while mental disturbances occurred in over one-half the cases of cancer of the brain, they were rare in tubercle, an hypothesis which subsequent investigations have not confirmed. Some years later Bernhardt [2] found that in more than half of the tumours of the cortex and lobes there were mental symptoms.

In later years the frequency with which mental symptoms occur is regarded as somewhat greater. Giannelli [10] found them in 323 out of 588 collected cases, but he reckoned all cases with speech disturbance among the mentally disturbed. Schuster [25] estimated that fifty to sixty per cent. of all cases showed some such disturbance. Bramwell [5] believes that the great majority of cases show mental symptoms, and Bruns [6] holds that only rarely, when the growth is very small or has some special situation, is mental disturbance

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entirely absent. In the last edition of his "Lehrbuch" [21], Oppenheim says that we may consider it the rule that the sensorium is not unaffected at the height of the disease; a somewhat more liberal estimate than is indicated in his monograph [22] in Nothnagel's system.

It is possible that some of the earlier estimates, like Andral's, were due to the failure to lay sufficient stress upon the minor mental disturbances. Attempts have actually been made to estimate the frequency of mental disturbances by an enquiry into the frequency with which tumours are found at the autopsies of the insane. Fischer found a new growth only once in 318 autopsies, but Leubuscher found a growth four times in 350 autopsies, and Blackburn [4] 29 times in 1,642 autopsies, which is not quite as frequently as I have found tumours in autopsies of patients not insane (101 in 5,069 autopsies at the Boston City Hospital).

I have made an attempt to estimate the frequency of mental symptoms, in cases of tumour of the brain, from a study of the clinical history of 104 cases in which a growth of some nature was found at the autopsy. All but two of these cases are taken from the records of the Boston City Hospital. Many of them came under my own observation, and 39 of them have already been reported in a monograph published some years ago [11]. For the rest, I am indebted to the kindness of my colleagues at the hospital for the privilege of citing them here.

In these 104 cases, mental disturbances sufficient to attract attention were noted in 79, a trifle over 75 per cent. of the cases. On further study, however, and on applying a rigorous criticism, a large number will have to be excluded. In no less than 14 cases the tumour, although of considerable size, was but one manifestation of tuberculosis of the brain, and tubercular meningitis co-existed. In 6 cases there was marked alcoholism; in other cases the new growth was congenital (chordoma) or insignificant, or there were complicating diseases, Bright's disease, typhoid fever, and the like, or the patient was brought to the hospital unconscious, and no history of the previous condition could be obtained. Such cases, 40 in all, have been excluded, even though it

seemed probable that the symptoms of tumour and the symptoms of intercurrent disease might fairly be differentiated.

TABLE I.

	Grand total.	With mental symptoms.	Whole number considered.	With mental symptoms.	With early mental symptoms.
Frontal	8 ...	6 ...	6 ...	5 ...	3
Central	8 ...	7 ...	4 ...	4 ...	2
Parietal	2 ...	2 ...	2 ...	2 ...	1
Occipital	4 ...	3 ...	2 ...	2 ...	1
Temporal	7 ...	7 ...	6 ...	6 ...	5
Corpus callosum ...	4 ...	4 ...	3 ...	3 ...	3
Optico-striate ...	17 ...	13 ...	9 ...	9 ...	4
Corpora quadrigemina and pineal gland }	3 ..	3 ...	3 ...	3 ...	3
Pons	6 ...	4 ...	1 ...	1 ...	0
Cerebellum	10 ...	7 ...	7 ...	6 ...	1
Hypophysis	3 ..	2 ...	2 ...	2 ...	1
Base, anterior fossa ..	5 ..	5 ...	5 ...	5 ...	2
Base, middle fossa ...	1 ...	1 ...	1 ...	1 ...	0
Base, posterior fossa ...	2 ...	1 ...	1 ...	0 ...	0
Multiple	23 ...	13 ...	11 ...	8 ...	2
Not stated	1 ..	1 ...	1 ...	1 ...	0
	—	—	—	—	—
Total	104 ...	79 ...	64 ...	58 ...	28

In the 64 cases remaining, mental symptoms were noted 58 times, a trifle over 90 per cent. (Table I.) In considering these figures, many things must be borne in mind. The patients were hospital cases, often ignorant and stupid, often of foreign birth, with no friends or relatives at hand to give an intelligent history of their previous condition. Under such circumstances it is by no means easy to determine whether there has been any change in the mental condition, especially when the mental level is normally low. Furthermore, we must admit regretfully that hospital records are often defective, and that the house officers sometimes fail to report, or even to note, important symptoms. The patients, moreover, came under the care of different physicians, and sometimes were seen only cursorily, if at all, by the neurologists of the hospital. Finally, we lack a definite and generally-accepted method of examination of the mental condition of the average patient, such as we have for deter-

mining sensation, motion, or reflex activity. It would, therefore, not be surprising if the slighter mental changes should sometimes escape observation. It is surprising to me, however, that under such adverse conditions mental disturbances should be so frequently recorded, and it goes far to strengthen the opinion I expressed some fourteen or fifteen years ago [12], which Oppenheim [23] possibly regarded as extreme, "that in every case some change can be found by a competent observer who has known the patient intimately before; in other words, that there can be no gross lesion in the brain without some disturbance, greater or less, in the psychical functions."

A case under my observation a few months ago will illustrate this point. The symptoms pointed very definitely to a tumour in the occipital lobe, but no autopsy could be obtained. The patient was a young man of unusual mental attainments, who had won high honours at two great universities. He was of a high-strung, intense, poetical nature. On many occasions it seemed as if there were no mental impairment whatever, but closer study revealed almost invariably a readily-induced exhaustion of the brain, so great at times as to compel a cessation of enquiry, or even of ordinary conversation. With this was associated an exaggerated emotional instability and a good deal of mental depression. The latter, however, might be regarded as natural under the depressing conditions. He had a quadrant hemianopsia, but under ordinary conditions there was no sign of any psychical blindness. Under the excitement, however, of an examination by a strange physician, he was temporarily unable to give the names of ordinary objects exposed to his view. Yet later, when free from excitement, he could do so normally.

Mental disturbance, as the result of a cerebral lesion, is what we might fairly expect *a priori* from our knowledge of the anatomy and functions of the brain. Anatomically we know that the brain is a mass of inter-connected neurones, each one of which is in contiguity with many others, and may be aroused through many different chains of neurones. If even a small group of neurones be obliterated by disease,

there are some lines of nervous conduction in which a link is broken, and the mental processes become just so far defective or slow in operation. If the single factor of its characteristic smell be eliminated from our concept of an orange, our mental patrimony becomes just so much the poorer. "Any destructive focal lesion of the brain," says Bianchi [3], in his recent admirable treatise on psychiatry, "must also have as an effect a diminution of the mental patrimony and of the vigour of the personality in some direction." With small lesions, however, especially if located in certain regions of the brain, such disturbance might be insignificant, and might not be detected by our present methods of clinical research.

We must also recognise the fact that there are certain growths which are apparently unattended with any cerebral symptoms whatsoever. The chordoma, one of which is included in my series, is a congenital growth, and, apparently gives rise to no symptoms in the few recorded cases where it has been found. Osteophytes in the skull and psammomata may sometimes attain considerable size without giving rise to any disturbance; the same is also true of the small cysts which develop in the choroid plexus. Furthermore, we occasionally meet with growths which are enclosed in a calcified capsule where no history of cerebral trouble can be elicited. Nine of the cases in the present series may be classed under one or the other of these various types, and may fairly be excluded from consideration. They all entered the hospital for some other disease, the symptoms were not cerebral, and the tumour was discovered only at the autopsy. Various cases are on record where the presence of a large tumour was not suspected during life, and where the cerebral symptoms were absent or insignificant. In the present series of cases, however, there were no instances where a large growth existed without cerebral symptoms, although there was often a question whether those symptoms were due to the growth or to intercurrent disease. The statement which I have made above, therefore, needs a little modification to this effect, that in every case of brain tumour presenting any cerebral symptoms some mental symptoms

can probably be discovered—at least, by a competent observer who has known the patient intimately before.

The cases here under consideration, however, were, of course, seen in the terminal stages of the disease a few weeks, or sometimes a few days, before death. One of them, which only recently came to autopsy, came under my personal observation over two years before. At that time the mental symptoms were insignificant, but in the last year of his life, after he had been trephined, they developed to such an extent that he became suspicious, deluded and violent, developed hallucinations of sight and hearing, and had to be committed to an asylum for the insane. Later he grew quieter, and for some months before death was dull and stupid, gradually becoming comatose in the weeks preceding death. In this case the optic nerve presented analogous conditions. So long as he was under my observation no neuritis could be discovered, but after he had been trephined, I learned that he became almost totally blind. The mental symptoms were observed comparatively early in the progress of the disease in 28 of the 64 cases. The importance of the early onset of such symptoms, with reference to the location of the growth, can be more advantageously discussed later, when we consider the relation between the symptoms and the seat of the growth.

In regard to the nature of the mental symptoms occasioned by a new growth within the skull, the prevalent opinion has been that expressed by Oppenheim and Bruns, that there is a steadily-progressing stupidity, beginning as somnolence and mental torpor, and eventually going on to stupor and coma. They both recognise the occasional occurrence of other mental conditions, such as melancholia, hallucinatory excitement, simple dementia, delirium, &c., as well as the peculiar form of mental weakness associated with a childish propensity to jest (*Witzelsucht*, *moria*, *puérilisme*), but Oppenheim regards them as rare, and Bruns believes that when specific psychoses occur, they are to be regarded as due to predisposition, and not caused by the new growth. Dupré [7] describes the characteristic mental condition as one of dulness of the intellect, affective torpor, and inertia of the

will, with, occasionally, ambulatory automatism. He lays especial stress upon a state of puerilism manifested by an infantile character of the psychical reactions, with various modifications of the affective tone, depression or excitement, often associated with the childish joviality above mentioned. Giannelli, however, has pointed out clearly that the mental symptoms of tumour of the brain may be varied and manifold, and this opinion has been confirmed by the exhaustive study of Schuster.

Schuster, as a result of a study of 775 collected cases, found that the conditions of simple mental weakness, dullness, sopor and dementia were present in 423 cases, while 352 cases presented some active symptoms which were classified as follows:—

Symptoms similar to those of general paralysis	...	29
Symptoms similar to those of chronic paranoia	...	19
Symptoms similar to those of melancholia and depressive states	... ..	57
Lachrymose with mental weakness	... ..	3
Depression with great irritability	... ..	1
Mental symptoms as in neurasthenia and hysteria	...	15
Mental symptoms as in mania	... ..	13
Euphoria, Witzelsucht, moria, hypomania	...	23
Irritability, "epileptic character," maniacal and similar states	... ..	95
Unrest, anxiety	... ..	1
States with confusion and hallucinatory delirium	...	52
States similar to Korsakow's psychosis	... ..	2
States similar to moral insanity	... ..	7
States with impulsive acts	... ..	3
Circular states	... ..	5
"Mental weakness with states of excitement"	...	10
State as in senile dementia	... ..	1
Unclassified	... ..	16

His investigations prove, therefore, that the conditions of stupor and mental torpor, although they are present in a greater proportion of cases, are not in such an overwhelming majority as the statements of Bruns, Oppenheim, and Dupré would imply, and that specific psychoses are sufficiently common to cast some doubt upon Bruns' statements.

My own investigations would agree in the main with those of Schuster, although I have found a lesser proportion of certain states than he has given. The largest number of cases, thirty-one in all, presented the recognised type of mental failure and dulness. The patients exhibited various degrees of languor, somnolence, dulness, apathy, mental torpor, failure of memory, and a general failure of all the mental functions, ending usually in complete stupor and coma. In the earlier stages it was sometimes noticeable, as has been observed by so many other writers, that, when aroused by sufficiently powerful stimuli, the mental processes could be performed clearly and correctly, but with unusual slowness.

Seven cases showed noticeable mental confusion and disorientation, with mental failure, failure of memory, irrelevancy in speech, mild mental wandering, somnolence, stupidity, and a dazed mental condition.

In fifteen cases the mental impairment went on to actual states of delirium, which became wildly maniacal in three patients, and which demanded restraint in several others. Actual hallucinations were occasionally noted. In these delirious states there was also mental failure, confusion, disorientation, failure of memory, and often more or less stupor, mental slowness, incoherence, and vague and unsystematised delusions.

Neurasthenic and hysterical states were occasionally noted in the earlier stages of the disease, but, with a single exception, there eventually developed more marked mental disturbances, so that the cases were eventually classified under one or another of the divisions given above. The diagnosis of hysteria or neurasthenia was, indeed, occasionally made at first by other physicians, although not quite as frequently as I have known it to be made in private practice. One or two patients, who afterwards became much demented, at first showed the scrupulousness and questionings so common in the neurasthenic conditions, while others showed the emotional instability of hysteria.

Vague and unsystematised delusions were occasionally noted in the confusional and delirious states, but in only two

cases were there definite delusions of persecution of a somewhat systematic character. One of these had also well-marked hallucinations of sight and hearing. Only one case presented symptoms of marked mental depression, unattended by any mental failure or confusion. The normal depression, natural upon the appreciation of the disease, must, of course, be omitted from this category. One patient also, whose case I reported some years ago [13], presented a fairly typical picture of general paralysis. The condition of childishness, *puérilisme*, emphasised by Dupré, was noted exceptionally, but true Witzelsucht was not observed. I have seen it in one or two cases of probable tumour in private practice, but in my experience it is a rare phenomenon in cases of brain tumour. It is, however, not uncommon in cases of incipient general paralysis.

I found no very striking differences as to the period of the disease at which the different types of mental disturbance developed. The mental symptoms were of early onset in about half of all the cases, 28 in 58, and they were also of early onset in about half of each of the three main groups, stupor (13 in 31), confusion (4 in 7), and delirium (8 in 16). One distinction, however, must be made. Although some mental symptoms appeared early in the course of the cases which became delirious, the delirium was usually a later feature. Confusion, mental dulness, somnolence and the like, characterised the earlier stages; delirium, violence, and profound stupor the later stages.

Turning now to the question of the relation between the seat of the tumour and the mental symptoms, it may be well first to deal with two general questions in regard to the relative position and size of the growth before we consider in detail the exact localisation.

Schuster has found that, in the collected cases of tumour with mental symptoms, the growth was located in a much larger proportion of the cases on the left hand side of the brain, excepting with tumours of the temporal lobe, where the proportions were about equal. In the frontal and occipital regions there were about four tumours on the left to three on the right, while in the central and parietal

regions the left-sided tumours were about twice as numerous. This [agrees with Phelps's [24] study of brain injuries, in which mental symptoms were much more frequent in injuries of the left frontal lobe than of the right. My own cases do not support these conclusions. Of the cases involving the cerebral lobes, only 11 were on the right and 9 on the left side, and the only one of these 20 cases where no mental symptoms were recorded was on the left side. Taking all the 64 cases, 28 were on the right side and 29 on the left, and of those without recorded mental symptoms, 3 were on the left side and none on the right.

In regard to the size of the tumours, it is obvious that a large growth is likely to give rise to more mental, as well as other, symptoms than a small one, and the resultant symptoms are, of course, apt to be more pronounced. I have arbitrarily divided my cases into three classes, large, where the growth was over two centimetres in diameter; medium, from one to two centimetres; and small, below a centimetre. Following this classification, the cases may be arranged as follows :—

Cases with mental symptoms	...	31	large	...	21	medium	...	5	small
„ without mental symptoms	...	2	„	...	3	„	...	1	„
„ rejected	...	7	„	...	13	„	...	20	„
Total	...	40	„	...	37	„	...	26	„

In one instance the size of the growth was not stated. In other respects the table gives us no very definite date, and gives no special support to our *a priori* conclusions.

Coming now to the special problem of the relation of the mental symptoms to the special regions of the brain, it may be well first to reproduce the three following tables from Schuster. In the first he gives the scale of frequency with which the different regions are affected by tumours in general, as follows :—

Cerebellum	...	...	...	...	...	21·6
Multiple	...	...	...	...	...	14·7
Frontal	...	...	...	...	...	12·1
Central	...	...	...	...	...	12·0
Brain stem and crura	...	...	...	...	...	9·9
Basal ganglia and ventricles	...	...	...	...	...	7·0

Occipital	...	...	...	...	4.3
Temporal	...	...	...	...	3.9
Hypophysis	..	...	...	...	3.8
Medulla oblongata	...	...	...	...	3.4
Parietal	...	...	...	...	3.3
Corpora quadrigemina and parietal	...	...	...	...	3.1
Corpus callosum	...	...	...	...	2.5

In the second he gives the relative percentage with which the different regions are affected in cases with mental symptoms.

Frontal	...	...	...	...	18.8
Multiple	...	...	...	...	18.6
Cerebellar	...	...	...	..	10.6
Hypophysis	...	...	...	.	7.0
Basal ganglia, ventricle	...	...	...		6.9
Brain stem, crura	...	...	...	...	5.9
Temporal	...	...	...	...	5.8
Central	...	...	...	...	5.2
Corpora quadrigemina, pineal...	...	...	...	...	5.0
Occipital	...	...	...	...	4.3
Corpus callosum	...	..	...	..	4.0
Parietal	...	...	...	...	2.4
Medulla oblongata	...	...	...	...	2.3

In the last he shows the percentage of mental disturbances in 100 cases in any given region.

Corpus callosum	...	...	...	...	100.0
Frontal	...	...	...	...	79.3
Temporal	...	...	...	...	66.6
Hypophysis	...	...	...	...	65.3
Occipital	...	...	...	...	60.0
Multiple	...	...	...	...	59.6
Corpora quadrigemina, pineal	...	...	...	...	53.8
Parietal...	...	...	...	...	52.1
Basal ganglia, ventricle	...	...	...	...	50.0
Cerebellum	...	...	...	...	35.5
Central	...	...	...	...	28.8
Brain stem, crura	...	...	...	...	25.0

Schuster, moreover, is inclined to the belief that the type of mental disturbance is dependent to some degree, at any rate, upon the location of the growth. The more active

mental disturbances are more frequent in tumours of the frontal, temporal and occipital lobes; the forms of simple mental failure in callosal and parietal tumours. Cases presenting the symptoms of moral insanity and general paralysis are commoner with frontal tumours; cases of the neurasthenic, hysterical or hypochondriacal type with frontal or parietal tumours; while cases of the type of paranoia and mania are rare in frontal tumours; and cases of confusion and delirium occur less often in frontal tumours than elsewhere, and are especially common in occipital growths. He agrees with other recent authors in the opinion that Witzelsucht occurs in tumours of any region, not exclusively in frontal tumours, and believes it is dependent somewhat upon the size of the growth.

Giannelli, drawing conclusions very probably from many of the same cases as those collected by Schuster, agrees with him in assigning special importance to tumours of the frontal lobe and corpus callosum in the production of mental symptoms. His conclusions are as follows: (1) Hallucination, when it exists, indicates an irritation of the corresponding cortical sensory centre, although we can not affirm with absolute certainty that the neoplasm is in the immediate vicinity of that centre; (2) the more the mental disorders—torpor, intellectual arrest, weakness of memory—are manifested at the beginning of the morbid process, the more likelihood there is that the neoplasm is in the frontal lobe and especially the prefrontal region; (3) tumours of other lobes, or in other parts of the encephalon, exhibit the mental disorders above mentioned later in the course of the disease; but, when the mental disorders do appear, they do not differ materially from those manifested by tumours of the frontal lobe, excepting that tumours in the speech area may produce the form of dementia characteristic of aphasic disturbances; (4) these mental disorders indicate a more or less intense and more or less diffuse alteration of the cortical morphological elements; (5) tumours of the corpus callosum are always (?) accompanied by mental disturbances; (6) the modifications of sentiment which may develop in the course of a cerebral tumour have no localising value; (7)

when a cerebral tumour presents the syndrome of general paralysis, it is very probably in the frontal lobe; (8) When ideas of grandeur develop in the course of a cerebral tumour, the tumour is probably in the frontal lobe; (9) Witzelsucht is indicative of a tumour in the frontal lobe, probably on the right side; (10) marked alterations of character, with irritability, violence, insolence, obscenity, threats, indicate a frontal growth; (11) when, in the course of a cerebral tumour, there are exhibited disordered actions of a higher order (forced actions with consciousness) the growth is most probably near the psycho-motor zone, and preferably in the frontal lobe.

In spite of the importance ascribed to tumours of the frontal lobe in the production of mental symptoms, by both Giannelli and Schuster, and in spite of the corroborative evidence, both on the clinical side and from animal experimentation, Müller [19] has contested the generally-accepted opinion that the frontal lobes are associated with the higher psychical functions. Although Müller's arguments are somewhat plausible, I do not think that he has succeeded in controverting the great mass of evidence that has been collected which ascribes to the frontal lobes an important part in the mental processes, although they are in no sense to be regarded as the sole psychical centres. The integrity of the mind must depend upon the harmonious functioning of many regions of the cerebral cortex, and the analysis of even a simple concept will almost invariably show that it is the result of the combination of many sensory processes which demand unbroken links of succession between several widely separated sensory regions. The occipito-temporal region, and especially the zone of language, must play an extremely important part in our ideational processes, and the probability that the corpus callosum is a huge mass of association fibres renders its integrity also important. It is readily conceivable, assuming that a given association tract with a definite function runs from the occipital lobe through the corpus callosum to the opposite frontal lobe, that a lesion in any one of the three regions might break the conduction and give rise to the same phenomena of deficit, just as a lesion

anywhere from the cuneus to the chiasma may give rise to the same symptom of deficit—hemianopsia. It is not unlikely that disturbances in the higher visual centres in the occipital region in Flechsig's posterior association centre, may be responsible for much of the disorientation of confusional states, for example, and that the special phenomena of attention, and many of the ideas of personality, are depen-

TABLE II.

	Total.	Total with mental symptoms.	Dull, stupor.	Confused.	Delirious.	Paranoid.	General paralysis.	Melancholia.	Neurasthenia.
Frontal	6	5 iii.	5 iii.	—	—	—	—	—	—
Central	4	4 ii.	2 ii.	—	1	1	—	—	—
Parietal	2	2 i.	1 —	—	—	—	—	—	1 i.
Occipital	2	2 i.	1 i.	—	1	—	—	—	—
Temporal	6	6 v.	2 i.	2 ii.	1 i.	—	1 i.	—	—
Corpus Callosum	3	3 iii.	—	—	3 iii.	—	—	—	—
Optico-striate... ..	9	9 iv.	7 ii.	—	2 ii.	—	—	—	—
Corpora quadrigemina and pineal gland	3	3 iii.	2 ii.	—	—	1 i.	—	—	—
Pons	1	1 —	1 —	—	—	—	—	—	—
Cerebellum	7	6 i.	5 i.	—	1	—	—	—	—
Hypophysis	2	2 i.	—	1 i.	1	—	—	—	—
Base, anterior fossa	5	5 ii.	1 i.	3	1	—	—	—	—
Base, middle fossa	1	1 —	—	—	1	—	—	—	—
Base, posterior fossa	1	—	—	—	—	—	—	—	—
Multiple	10	7 ii.	3 —	1 i.	3 i.	—	—	1	—
Not stated	1	1 —	1 —	—	—	—	—	—	—
Total	64	58 xxviii.	31 xiii.	7 iv.	15 viii.	2 i.	1 i.	1 —	1 i.

The number of cases with early mental symptoms is given in roman numerals.

dent upon associated processes in the frontal lobes ; but this is still undetermined, and the cases at present under consideration unfortunately give no definite information upon the subject.

Coming now to the cases that I have collected, and considering them in detail (Table II.), five of the six cases of tumour of the frontal lobe, or, to speak more accurately, of the prefrontal portion thereof, exhibited signs of mental disturbance. In all cases this disturbance was simple mental failure with marked dulness, but in only three of the cases was it noted as being among the early symptoms. The only case where no mental symptoms were noted was a sarcoma, the size of an English walnut, at the foot of the left second frontal convolution near the precentral sulcus, and has already been reported [14]. It is curious that this is the only case of tumour of the prosencephalon or diencephalon in which no mental symptoms were recorded, but mental dulness may readily have been overlooked, as the patient was in bed for a number of weeks, complaining constantly of intense headache, and therefore being averse to any attempts at conversation.

Of four tumours in the Rolandic region, two presented symptoms of mental dulness early in their course, a third, later in the disease, was noisy and delirious, and the fourth, to which I have already referred, finally developed hallucinations and delusions of persecution.

One of the two parietal cases presented neurasthenic symptoms early in the disease. The other became dull and stupid toward the close.

There were six temporal tumours. Two of these were mentally dull, two confused, one delirious, and one presented a typical picture of general paralysis. One of the dull cases did not show much mental change until late in the disease. In all the rest the mental symptoms were of early occurrence.

Every one of the three callosal tumours showed mental symptoms early in the disease, and all became confused, delirious, violent, and demented. One case had hallucinations.

Seven out of nine cases of a growth in the optico-striate region were mentally dull, but only two showed this symptom early. Two other cases showed early mental symptoms, and both became delirious, requiring restraint, one being wildly maniacal.

Two cases of tumour of the corpora quadrigemina became dull early, and the third also showed early mental impairment, with delusions of persecution. One of them manifested early various neurasthenic symptoms, scrupulosity, and a sense of unworthiness, later growing demented.

The only case of tumour of the pons was mentally dull.

Five out of seven cerebellar tumours were mentally dull, but only one showed this mental failure early. The sixth was delirious. In the seventh case no mental symptoms were noted, but she had headaches with intense vertigo, aggravated by any effort, so that mental symptoms may well have been overlooked.

One tumour of the hypophysis showed mental confusion early in the disease. The second was delirious toward the close.

Of the seven tumours at the base of the brain, five were in the anterior fossa. Of these, one became dull early, three showed mental confusion later in the disease, and a fifth was delirious, showing mental disturbances early. One tumour in the middle fossa became delirious later in the disease. In only one case of a tumour in the posterior fossa, a growth of the cerebello-pontine angle, not involving the brain deeply, there were no noteworthy mental symptoms.

Eleven tumours were classed as multiple, but two other cases might fairly be regarded as in this class, one a multiple growth in the optico-striate region, the other a multiple growth in the pons. They have, however, already been considered under the other headings as the growths were close together. Three of these eleven cases showed mental failure late in the disease. One was confused early, and three were delirious. One of them showed mental disturbances early. One was mentally depressed. Of the three cases where no mental symptoms were recorded, two were

under observation a very short time, one dying suddenly with cysticerci in the brain, the other dying suddenly of surgical shock. A third case, with multiple gliomata in the basal ganglia, has already been reported [15].

In one other case with mental failure the autopsy record of the findings in the brain was lost, the only note being "glioma of brain."

Since mental symptoms were so frequent, no matter in what part of the brain the tumour was located, and since the failure to note such symptoms in a few cases is susceptible, for the most part, of explanation on other grounds than by the assumption that mental symptoms did not exist, the series of cases here presented can hardly give much support to any theory which seeks to establish one special psychical centre in the brain. If, however, we study the cases according to the period of development of the mental symptoms, it may perhaps be of greater advantage.

If we note the early development of the mental symptoms as shown in the final column of Table I., the relative importance of the different regions of the brain in regard to psychical functions becomes more pronounced. In every case of tumour of the corpus callosum or tumour of the corpora quadrigemina, the mental symptoms were of early development. This is in accordance with the other data which indicate that callosal tumours are most frequently attended with mental symptoms on account of the important part played by the corpus callosum in the processes of association. Growths involving the region of the corpora quadrigemina and pineal gland are usually attended with marked dilatation of the lateral ventricles on account of the blocking of the *iter a tertio ad quartum ventriculum*. They thus give rise early to a marked increase of intracranial pressure which might favour the early onset of mental disturbances. Next in importance to these regions in favouring the early onset of mental symptoms come the temporal and frontal lobes. A study of these cases, in fact, has led me to suspect that the temporal lobe, apart from its association with the function of speech has perhaps as important a share in the psychical functions of the brain as the frontal lobe. The other

regions of the prosencephalon, with the opticostriate region and the hypophysis, come next, and the brain stem plays a less important part.

The pathogenesis of the mental symptoms in cases of cerebral tumour is susceptible of various explanations. The mental disturbance may be regarded as a focal symptom, either of deficit or irritation, due to the destruction or irritation of certain centres which have especial psychical functions ; or it may be a general symptom, due either to the increased intracranial pressure, or to the formation of certain toxins in the brain, either from the new growth itself or by the disturbance in circulation caused by the growth.

From a study of these cases we have found that the most common psychical states are those of confusion, delirium and mental stupor or dementia. These states often co-exist, or at least are often present in successive stages of the same case, in mental diseases due to causes other than tumour. This is especially true of the toxic and infectious psychoses, or of the various mental affections which Bianchi has brought under the one comprehensive heading of sensory phrenosis. Persistent hallucinations, obsessions, phobias and limited systematized delusions with a clear sensorium and fairly active intellectual processes were notably rare. It is fair to assume that these later syndromes are dependent upon some derangement in a definite group of association neurones, limited, it may be, in number, but possibly having connections with one another over a wide cortical area. A new growth may disturb some of these growths in its initial stage, but as it increases in size, especially in the case of a growth so large as to involve several cortical regions and the basal ganglia as well, so that its regional classification becomes a problem, the mental symptoms will become more general and widespread. While it seems probable that the functions of certain areas, notably the frontal and temporal lobes, are especially of a complex psychical nature, and that those areas are especially to be considered as psychical association centres, and that the corpus callosum is to be regarded as a vast association tract connecting various association centres, it is not strange if a good-sized lesion in

one of those centres should disturb many groups of associated neurones and lead to more diffuse psychical disturbances. In studying the early development of mental symptoms, I have already indicated the relative importance of certain areas in the possible production of such symptoms, but the fact that mental symptoms may arise from a growth anywhere within the cranium forces upon us the conclusion that other factors beside the location are of importance in their production.

Vigouroux [26] has maintained that there is no special region of the brain which elaborates intelligence, but that the intellectual function requires the co-operation of all parts. He thinks that a diffuse alteration of the cortex is requisite to produce obnubilation, confusion and dementia, and that when these symptoms occur they are due not to the growth alone, but to compression, chronic meningitis, and the formation of toxins. Giannelli, indeed, has demonstrated the existence of these diffuse changes in a number of cases of tumour, finding changes in the cells and disappearance of tangential fibres in all parts of the brain.

The factor of pressure is undoubtedly of great importance. We know that pressure will inevitably lead to inhibition of all the cerebral functions. Levassort [18] has tried to show that the habitual mental symptoms of tumour are obnubilation, confusion and weakening of the intelligence, and that these are due to compression of the brain. Outbursts of delirium with hallucinations are exceptional, and are due to toxic influences. Systematized delusions are due to co-existing degeneracy and not to the tumour at all. This seems somewhat strained. Increased pressure existed in many of my cases and was an important factor, but not the only factor. I have already referred to a case with hallucinations of sight and hearing and delusions of persecution. When he first came under observation he had typical Jacksonian epilepsy with slight paresis of the right hand due to an endothelioma growing from the dura in the left mid-Rolandic region. At that time he had no optic neuritis, no noticeable mental disturbances and very little headache. He passed from my observation, but nine months later he was

trephined. It was reported that the growth could not be removed on account of hæmorrhage. A hole four centimetres in diameter was left in the skull, and hernia developed. A year later he became blind, the mental symptoms above mentioned developed, and he was sent to an asylum. Later he became extremely dull and stupid, dying in coma. The mental symptoms and blindness developed after the pressure had been relieved by trephining.

In considering the possibility of toxic influences, I have tried to see whether the nature of the growth had any influence on the development of mental symptoms. That a rapidly-growing tumour will more speedily cause mental symptoms than one of slow growth is obvious, but beyond that I have been unable to find any special relation between the nature of the growth and the form of mental disturbance, except that delirious conditions were more apt to occur in cases of sarcoma, as the accompanying table will show. (Table III.)

TABLE III.

Nature of growth.	Total cases.	Total considered.	With mental symptoms.	Dull, stupor.	TYPE OF MENTAL DISTURBANCE.					
					Confused.	Delirious.	Paranoid.	General paralysis.	Neurasthenia.	Melancholia.
Tubercle ...	21	4	4	2	—	2	—	—	—	—
Glioma ...	17	14	12	9	2	—	—	1	—	—
Sarcoma ...	11	11	9	3	1	4	1	—	—	—
Gumma ...	8	8	8	6	1	1	—	—	—	—
Cyst ...	5	4	3	1	—	1	—	—	1	—
Endothelioma ...	4	4	4	2	—	1	1	—	—	—
Cholesteatoma ...	3	2	2	1	1	—	—	—	—	—
Carcinoma ...	1	1	1	1	—	—	—	—	—	—
Cysticercus ...	1	1	—	—	—	—	—	—	—	—
Dermoid cyst ...	1	1	1	—	—	1	—	—	—	—
Angioma ...	1	—	—	—	—	—	—	—	—	—
Aneurysm ...	1	—	—	—	—	—	—	—	—	—
Chordoma ...	1	—	—	—	—	—	—	—	—	—
Enchondroma ...	1	—	—	—	—	—	—	—	—	—
Fibroma ...	1	—	—	—	—	—	—	—	—	—
Osteophytes ...	1	—	—	—	—	—	—	—	—	—
Psamomma ...	1	—	—	—	—	—	—	—	—	—
	79	50	44	25	5	10	2	1	1	—

The cases of diffuse multiple sarcomatosis of the brain, four in number, deserve special mention. One of them entered on account of a huge sarcoma of the neck, which was curreted, the patient dying of shock the same day. No note was made of his mental condition by the surgeons. In two of the others there was marked mental confusion, wandering and delirium; in the third there was simple mental failure.

I have already shown the resemblance between the mental symptoms usually met with in cases of cerebral tumour to those occurring in toxic psychoses. Dupré, an ardent advocate of the toxic origin of these symptoms, has emphasised this point. He believes that the mental disturbances are due to the impregnation of the brain by products of disassimilation, cellular toxins coming from the new growth. He shows that many of the symptoms of tumour of the brain, such as headache, mental disturbance and neuritis, may also arise in toxic conditions, such as uræmia, diabetes, and lead poisoning. He believes that the new growth secretes toxic substances growing at the expense of the brain, and that the gray matter of the brain is peculiarly sensitive to such poisons. He has found, furthermore, lesions throughout the brain, in cases of tumour, similar to those found in toxic-infectious troubles, and calls attention once more to the importance of toxins in the production of optic neuritis. Pressure alone is hardly capable of producing optic neuritis, but, when pressure is combined with the influence of some toxine, neuritis is speedily produced. The cases under consideration reveal nothing as to the nature, or even the existence, of these toxins, but it seems probable that while the situation of the growth is often of influence in producing mental symptoms, especially in the early stages of the disease, and possibly has an influence upon the nature of the symptoms, a combination of increased cranial pressure and the action of toxins is of greater importance, and in some cases may be the only factor to be considered in the production of such symptoms.

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