would be interesting to know whether similar results have been found in India and elsewhere within the tropics, or may yet be obtained.

Computing $\delta T$ by means of these formulæ, and applying the results to the temperatures at Kingston, we have

| | Mean | Min. |
|---|---|---|
| Kempshot ... ... ... | 72°·7 ... ... | 68°·0 |
| Cinchona Plantation ... | 62·6 ... ... | 57·5 |
| Portland Gap ... ... ... | 60·5 ... .. | 54·7 |
| Blue Mountain Peak ... | 54·4 ... ... | 45·6 |

which are fairly satisfactory.

Putting $\delta P$ = 30 inches, the minimum formula gives $-311°$ as the temperature of space, the thermometer being shaded from the sun by any spherical body such as the earth or moon.

Putting $\delta P$ = 30 inches, the mean formula gives $-81°$ as the mean temperature of a body devoid of atmosphere, such as a meteorite pursuing its course in space, or the moon, at the mean distance of the earth from the sun.

An expression for maximum temperatures cannot be as easily deduced; but if the surface of the meteorite or the moon which is turned from the sun be $-311°$, and if the mean temperature be $-81°$, it follows that the maximum temperature of the surface turned towards the sun must be about $+149°$.

Jamaica, February 12 MAXWELL HALL

### Electricity and Clocks

IN addition to the plan pointed out by Prof. Sylvanus Thompson (the correct way to repeat from a striking clock to electric bells), I believe I have seen an arrangement in Dublin whereby a single port or going train only is made to strike the hours on an indefinite number of electric bells. I believe this mechanism is a patent. HORLOGE

Sandymount, March 2

### Top-shaped Hailstones

ON August 6, 1885, a hailstorm occurred in this neighbourhood, during which two waterspouts were seen. After one of these had burst, a fall of hailstones, almost exactly similar to those described by Mr. Middlemiss in your issue of March 3 (p. 413), commenced and lasted for some minutes. I do not remember to have noticed that there was a mass of clear ice at the base of the cone, but the banding was very distinct.

Beside the horizontal stratification there was another perpendicular one, giving the hailstone the appearance of being composed of alternate cylinders of clear and white ice. If the hailstones which Mr. Middlemiss saw at Ramnagar showed this peculiarity, he will perhaps be kind enough to communicate the fact through your columns. Sketches of the hailstones which fell in this district were published in the *Meteorological Record* soon after the occurrence, but I cannot give the precise date of the copy. T. SPENCER SMITHSON

Facit, Rochdale, March 7

### The Present Southern Comet

EITHER the present brilliant southern comet is periodic, or one of a large family of comets, moving in similar orbits and possessing marked similarities of structure. Its orbit, as far as an orbit can be determined from the approximate positions of a very indefinite nucleus, is similar to those of the 1843 and 1880 comets. In Grant's "History of Astronomy" the following description of the 1668 comet occurs:—"It appeared a little above the western horizon. The tail measured 23° in length, and resembled a huge beam of light. The head was so small as to be scarcely visible. The observations will be represented with sufficient accuracy by the elements of the orbit of the comet of 1843." A fairly accurate description of the present comet. There are other comets—1618, 1689, 1702—which possess this strong family likeness. If these comets be not one and the same, they must all have had a common origin. I do not know if it has been noticed that the aphelia of their orbits lie within a few degrees of Sirius. It may be possible that they have all been ejected from that gigantic sun; at any rate, it is impossible that they could have been attracted from nebulous masses lying beyond Sirius. A. W. R.

Lovedale, South Africa, February 1

### The Earthquake

I EXAMINED my magnetograms very carefully on the day of the earthquake in North Italy, and I find no trace of any special disturbance on the H.F. trace similar to that on the Kew curve. It may be well to place this on record, as it may aid in fixing the limits of the disturbance. S. J. PERRY

Stonyhurst College, Blackburn, March 7

## CEREBRAL LOCALISATION[1]

### I.

IT is rather more than ten years since the first edition of this book came under review in the pages of this journal. And it was intrusted to very able hands, for the reviewer was George Henry Lewes, himself an experimentalist in this branch of physiology, and of the highest distinction as a philosopher and psychologist. The review is courteously but unflinchingly hostile: exception is taken to some of the facts and to most of the deductions of the author; although the value of the work, from its richness in suggestions as well as in facts, is ungrudgingly admitted. Mr. Lewes especially complains that the book "is so deficient in the indispensable correctives of counter facts and arguments, that the reader must be cautioned against accepting any position unless elsewhere verified. . . . From one cause or another there is a disregard of counter evidence, which, in a second edition, I should seriously urge him to rectify. . . . This disregard arises from no unfairness, but simply from the one-sidedness which comes from preoccupation with certain views."

The increased size of the work (498 pages instead of 323) is, no doubt, in part due to an endeavour to carry out this suggestion, although the growth of the subject may of itself, in great measure, account for such increase. Indeed, it must be confessed that the characteristic complained of by Mr. Lewes has not by any means entirely disappeared, and the student who may consult its pages must bear in mind that the book still remains the gospel of the functions of the brain "according to Ferrier."

The pervading idea of the work is expressed by the term "localisation of function." It was against this idea (and especially against certain applications of it) that Mr. Lewes brought to bear the full powers of his criticism.

One serious objection which was urged by him against many of Dr. Ferrier's results (those of localised extirpation) was that he was unable to keep the animals alive long enough to allow the effects of Disturbance of function to subside, so as to leave only the effects of Removal to be estimated. But the use of antiseptics has now permitted this objection to be removed, since there is no longer, in most instances, the same difficulty in preserving the animals, as was the case in Dr. Ferrier's first experiments.

It is further urged by the previous reviewer that "neither the effects of Disturbance nor the effects of Removal are to be taken as conclusive evidence that the function disturbed or removed is the function of the organ operated on." [But although not of themselves conclusive, yet if looked at in conjunction with other evidence they may furnish important indications regarding the function of the organ.] Mr. Lewes further affirms that "whenever a function persists or reappears after the destruction of an organ, this is absolutely conclusive against its being the function of *that* organ," meaning, of course, of that organ alone. That, in the case of recovery or reappearance, partial or complete, of a lost function, another organ previously possessed of a different function has vicariously taken its place, is a scarcely tenable hypothesis. And yet there are well-recorded instances of such reappearance: as in the case of Goltz's dogs, which recovered some of the lost power of voluntary movement; and in that of the visual disturbances which are caused by lesions of the occipital lobe, in which

[1] "The Functions of the Brain." By David Ferrier, M.D., LL.D., F.R.S. Second Edition, re-written and enlarged. (London: Smith, Elder, and Co., 1886.)

I have myself frequently observed recovery, to all appearance complete. It appears to me that the idea expressed by the term "concentration of function" harmonises much more fully with our existing knowledge of the facts relating to this question than the more inflexible phrase "localisation."

It is time, however, to turn to the edition which lies before us. Dr. Ferrier, in his preface, tells us that the book has been almost entirely re-written, and, in point of fact, so much has been added and modified as to constitute this edition, in many respects, a new book. But the principal teachings of the original—those to which the book from the first owed its chief interest—the doctrines, namely, therein advocated regarding the localisation of cerebral functions, are, it is claimed by the author, maintained in all essentials unchanged. Since it is to the exposition of these doctrines, and especially of the experimental facts upon which they rest, that the student of physiology or psychology would naturally first turn, in order to discover what that is new may have been adduced in support of the Ferrierian teachings, and in what manner the hostile attacks which have been directed against them are met by their author, no apology is needed if we devote our attention first and chiefly to those parts of the book which deal with this important question.

After it had been found impossible to deny the correctness of the facts regarding electrisation of the cortex of certain regions of the brain, a vigorous onslaught was made from various quarters upon the method of experimentation. It was especially contended (by Dupuy and others) that the movements produced by this method are really due, not to excitation of the cortex cerebri itself, but to conduction of the current to the basal ganglia (corpora striata). But a single new fact entirely overthrows the last remnant of this objection, since it has been shown (by Franck and Pitres) that similar movements may be caused by mere mechanical stimulation of the cortex (p. 228). Indeed, the same observers entirely deny that the basal ganglia respond at all to direct electrical excitation, a statement which we shall afterwards see is not, however, accepted by Dr. Ferrier.

In the review above alluded to, Mr. Lewes alleges two principal facts against the doctrine that the gray matter of the cerebral cortex is directly excitable, viz.: (1) the fact that only the electrical current causes an excitation,—mechanical and chemical stimuli have no such effects, because they cannot pass through the cortex to reach the white substance; (2) what he terms the "decisive experiment" of Dr. Burdon Sanderson. "If that part of the surface of the hemisphere which comprises the active spots is severed from the deeper parts by a nearly horizontal incision made with a thin-bladed knife, . . the result is the same as when the surface of the uninjured organ is acted upon" (Proceedings of the Royal Society, No. 153). But we have just seen that, under suitable conditions, the cerebral surface may be excited mechanically; and, with respect to the second fact, I imagine that Dr. Sanderson would now be the first to admit that his results were due either to imperfect severance or to the spreading of a current of too great intensity.

Moreover, the study of the characters of the contractions which result from excitation of the cortex has tended to show that its excitation is indeed a stimulation of centrifugally discharging nerve-centres, and in conformity with this view it is found that destruction of the cortex in the excitable regions is followed not only by immediate paralysis of the parts in which movement is evoked on excitation, but also by speedy degeneration of the efferent nerve-fibres. The arguments upon this point are set forth briefly, but clearly, by the author (pp. 231–33).

With regard to the results of localised excitation of the cortex (in the monkey), some modifications which are not wholly unimportant have been introduced; but to obtain these the author appears rather to have again consulted his original memoir (Proc. Roy. Soc., No. 161, 1875) than the results of any new experimental investigations. The facts that the excitable region extends over the margin of the hemisphere to include the marginal gyrus upon the mesial surface, and that this part of the excitable region is associated with movements of the leg and trunk, had not been definitely determined at the time of publication of the first edition, but are duly recorded here (p. 245).

The general correctness of Dr. Ferrier's statements regarding the results of localised excitation of the brain in the monkey (and, from its resemblance to the human brain, these will be those of chief interest to most readers) seems at the present time to be universally admitted. I have myself so frequently had the opportunity of verifying them as to have no doubt of their general applicability. But the *inferences* which he has drawn from the results of excitation have not, as we shall presently see, been allowed to remain unquestioned.

The method of localised ablation is of yet more importance for the determination of the functions of the cortex than that which we have just considered. In carrying out this method, the necessity of strict adherence to Listerian precautions is demonstrated when we compare the results which were obtained in the first instance by Dr. Ferrier himself, and recorded in the first edition of this book, with those which have been yielded by the antiseptic method in the hands of Prof. Yeo and himself, in a series of experiments undertaken with the express object of testing the applicability of that method to brain-surgery, several of which experiments are recorded in this edition. The path which their experiments indicated has since been trodden by my colleague Mr. Horsley and myself, and it is to-day a beaten track leading to previously undreamed-of possibilities in surgical science. The fact that the brain can be as effectually searched with a view to the discovery and removal of a tumour as any other part of the human body is an advance of vast extent—a boon to suffering humanity of incalculable value. And that this boon has been acquired, could have been acquired, solely as the result of experiments upon animals, is a fact which may well make the most frenzied of anti-vivisectors pause ere he would deny to his fellow-men the opportunity of acquiring benefits of such inestimable worth!

At the present time it is admitted, even by those physiologists who, like Goltz, have been hitherto accounted the most strenuous opponents of the doctrine of cerebral localisation, that the results of localised extirpation of the cortex vary with the part removed. These results consist of a loss or diminution in the power of voluntary action of different groups of muscles, or of a loss or defect in the appreciation of sensory impressions (but, according to some observers, both volition and sensibility may be at the same time affected by the destruction of certain parts): lastly, from experiments upon some parts of the hemisphere, it may happen that no effect appreciable to the observer is obtained. With respect both to these results and those obtained by excitation, Dr. Ferrier, in the first edition of this work, took up certain positions which have in the meanwhile been vigorously assailed from various quarters. These positions are, in the present edition, for the most part defended by the author with no less vigour, although one or two have been somewhat shifted, and one, at least, altogether abandoned.

In order to make clear these positions to those readers of NATURE who may not have followed closely the controversies which have been carried on during the past fifteen years regarding this subject of cerebral localisation, it will be necessary briefly to describe, with the aid of a diagram, the main features of the external configuration of the monkey's brain (every fissure and convolution in which is represented in the human brain). It will then be easy to indicate the regions to which special functions were originally ascribed by Dr. Ferrier, the modifications

which he has since seen reason to introduce in the original scheme, and the results which have been arrived at by certain other workers in this field of research.

Fig. 1 is a diagram of the outer surface of the left hemisphere of the monkey's brain: in it the fissures are represented by black lines. It is seen to be crossed obliquely by six prominent fissures (besides less important

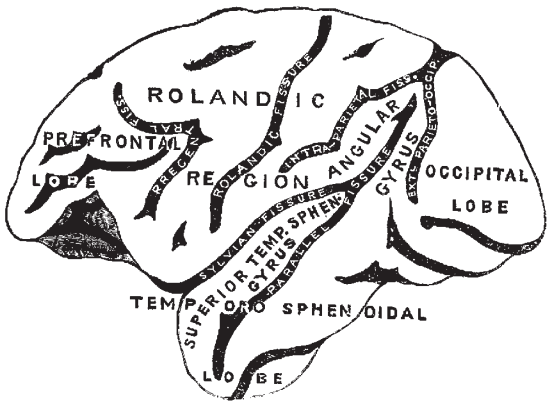


FIG. 1.

depressions). These, enumerated from before back, are the pre-central, Rolandic, intra-parietal, Sylvian, parallel, and parieto-occipital fissures. The anterior portion of the hemisphere in front of the pre-central fissure is termed the pre-frontal lobe. The part of the brain behind this, and bounded behind by the intra-parietal and Sylvian fissures, may be designated the Rolandic region, since it includes the Rolandic fissure. The next part, posteriorly, lies in the angle between the intra-parietal and parieto-occipital fissures, and has the end of the parallel fissure running up into it: it is known as the angular gyrus. Behind the parieto-occipital fissure is the occipital lobe. The rest of this surface of the hemisphere below and behind the Sylvian fissure is the temporo-sphenoidal lobe: the convolution in this which lies between the Sylvian and the parallel fissures, and which is thus very well marked off from the rest of the lobe, is the superior temporo-sphenoidal gyrus.

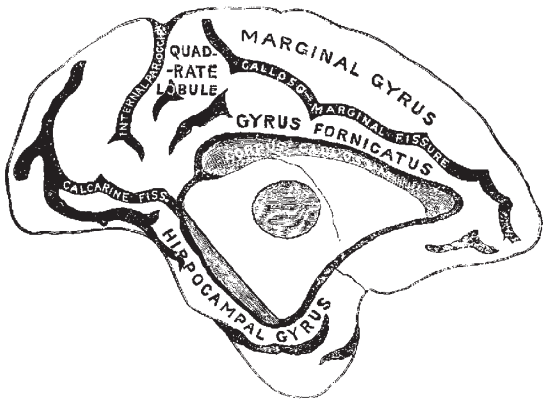


FIG. 2.

Fig. 2 represents the mesial and under surface of the left hemisphere. We here see, above the cut corpus callosum and the other parts which unite the two hemispheres, two convolutions running longitudinally, and separated by a well-marked fissure, the calloso-marginal. The upper one is termed the marginal gyrus, the lower the gyrus fornicatus. The latter expands posteriorly into the quadrate lobule, and is then continued around the posterior end of the corpus callosum on to the under surface of the temporo-sphenoidal lobe, where it becomes continuous with the hippocampal gyrus. The internal parieto-occipital fissure, continuous above with the external one of the same denomination, cuts off, like that, the occipital lobe from the rest of the brain.

Briefly stated, the positions taken up by Dr. Ferrier in the first edition of this work were as follows:—

(1) The Rolandic region is motor. This is the part of the hemisphere from which all volitional impulses (at least for the limbs, head, and face,—about the trunk-muscles nothing was ascertained) issue. It is not connected with sensory perceptions of any kind, not even with those of the muscular sense.

*Evidence.*—Electric excitation in this region in animals produces definite and co-ordinated movements of muscles of the limbs, neck, and face, similar to those which occur in voluntary efforts. Extirpation is followed by immediate and permanent paralysis of those muscles without the occurrence of any loss or impairment of sensation in the corresponding parts.

(2) The angular gyrus is the centre for vision with the opposite eye.

*Evidence.*—Electric excitation of this convolution produces movements of the eyes towards the opposite side, contraction of the pupils, and closure of the eyelids as if under the stimulus of a strong light. Movement of the head to the opposite side is also frequently produced. Extirpation of the angular gyrus on one side causes complete blindness in the opposite eye, but this is not permanent if the angular gyrus of the other hemisphere be intact. If this also be removed the loss of vision is complete and permanent.

(3) The superior temporo-sphenoidal convolution is the centre for hearing with the opposite ear.

*Evidence.*—Electrical excitation of this convolution produces sudden retraction or pricking up of the opposite ear, opening of the eyes, dilatation of the pupils, and turning of the head and eyes to the opposite side. "These phenomena resemble the sudden start and look of surprise which are caused when a loud sound is made in the opposite ear." Lesions of the temporo-sphenoidal lobe of one side which involve the superior convolution produce deafness of the opposite ear, as evidenced by the fact that the animal becomes deaf to ordinary sounds when the ear upon the same side as the lesion is stopped with cotton-wool. When the lesion is established bilaterally, so as to cause destruction of the superior temporo-sphenoidal convolution on both sides, the animal fails to respond to auditory stimuli.

(4) The hippocampal region is concerned with the appreciation of tactile sensation, if not of other forms of sensibility.

*Evidence.*—Unilateral destruction of this region is followed by complete absence of response to cutaneous stimulation on the opposite side of the body (without any true motor paralysis, although there may be disturbance of voluntary movements, "due to the loss of tactile sensation, by which movements are guided") "the effects being of a persistent character."

(5) The subiculum, or tip of the temporo-sphenoidal lobe, (under surface) is specially related to the sense of smell (in the nostril of the same side).

*Evidence.*—Electrical irritation of this part of the brain causes phenomena (torsion of the lip and partial closure of the nostril of the same side) such as are "produced by the direct application to the nostril of a powerful or disagreeable odour." Destruction of this region upon one side is accompanied, when the nostril of the opposite side is plugged, by impairment or loss of the olfactory sense: bilateral destruction by complete absence of reaction to olfactory sensations. "The comparative development of this region in animals in which the sense of smell is

largely developed, as in the dog, cat, and rabbit, strongly bears out this view."

(6) The lower part of the temporo-sphenoidal lobe, close to the subiculum, is probably to be regarded as the centre of taste.

*Evidence.*—Electrical excitation of this region produces movements of the lips, tongue, and cheek-pouches, which "may be taken as reflex movements consequent on the excitation of gustatory sensation." And the abolition of taste coincides with (bilateral) destruction of this region.

(7) The pre-frontal region is probably related to the reflective and intellectual faculties.

(8) The occipital lobe is related to the visceral sensations, such as hunger and thirst. The evidence in favour of this opinion was regarded even by its author at the time as very inconclusive, and since the subject is entirely ignored in the later edition we need not further consider it.

E. A. SCHÄFER

(*To be continued.*)

## THE UNIVERSITY COLLEGES

THE other day (March 3) the *Times* printed a letter from Prof. Jowett containing a powerful appeal to the State on behalf of the University Colleges which have recently been established in large towns by the exertions of private individuals. On Monday evening last, Mr. Mundella, having asked the Chancellor of the Exchequer whether his attention had been called to this letter, proceeded to inquire whether the Government "would introduce or facilitate the passing of a measure authorising local authorities to contribute towards the establishment and maintenance of schools and colleges adapted to the wants of their several localities, and would recommend to Parliament annual grants in aid of the same." That Mr. Goschen, so far as his personal sympathies are concerned, would have liked to give an affirmative answer to this question there can be no doubt; but, speaking as a member of the Government, he adopted a very discouraging tone. He was not in a position, he said, to recommend to Parliament annual grants in aid of local colleges. He admitted that it was an open question whether local authorities should not be empowered to aid such institutions, but the Government could not undertake to introduce or facilitate the passing of a measure dealing with the matter.

This decision is greatly to be regretted, and we must hope that the Government will soon be compelled by the pressure of public opinion to reconsider the subject. No one disputes that the University Colleges have done, and are doing, most valuable service to the communities in the midst of which they are placed. Until they were established, what is called a University education was accessible only to very well-off persons. The University Colleges have brought a high intellectual training within reach not only of the middle classes, but of working men, and large numbers of eager and intelligent students have taken advantage of the opportunities provided for them. Even, therefore, if no material benefit were derived by the nation directly from the University Colleges, it would be the clear duty of the State to afford them the help they need. But from the point of view of industry and commerce, as well as from the purely intellectual point of view, it is hardly possible to overrate the importance of these colleges. That our traders are being driven by German and other competitors from important markets is, unfortunately, only too certain; and it is not less certain that they will never recover the ground they have lost until English industry in all its branches is carried on in accordance with strictly scientific methods. This is beginning to be pretty generally understood, and it will be strange if the country does not insist that justice shall be done to institutions in which a serious attempt is being made to impart the kind of knowledge without which it is impossible for manufacturers to adapt their work to the rigid conditions of the present age.

No doubt it would be very satisfactory if the University Colleges could be made self-supporting, but this they cannot be. If those of them which do not possess any considerable endowment receive no aid from the Government, they will soon be placed in a position of grave difficulty; and the question will have to be faced, whether it is worth while to maintain them at all unless they can be maintained in a state of high efficiency. After all, it is no very great sacrifice that the State is asked to make for their benefit. What is claimed is simply that not less shall be done for the English colleges than is done for like institutions in Scotland, Ireland, and Wales.

An aspect of the question which does not always receive adequate attention was well brought out in Prof. Jowett's admirable letter. "Among other benefits," he wrote, "the influence which is exercised by these institutions on the society of a place is not to be forgotten. The residence in a large manufacturing town of a number of highly educated persons, having a variety of literary and scientific interests, is a social element of great value. They raise the tone of conversation; they create ideas and aspirations which would not ordinarily have arisen in a mercantile community. They break in on the dull monotony of wealth. The posts which they occupy, though poorly paid, afford leisure for study and opportunities for research. Among the holders of them are to be found some of the most promising young men of the country. Many of them are known by their writings, and a large proportion of the papers published in English scientific periodicals is a record of the work done in University Colleges."

The *Times*, we are glad to say, cordially supports the cause advocated by the Master of Balliol. "The good," it says (March 3), "which the local colleges do is not exaggerated by Prof. Jowett. They form centres of instruction for all the young men and young women of a town who desire to improve themselves. They foster the love of study, and teach the art of making use of time. 'They may have even kindled in the minds of one or two the spark of genius.' To put the matter on a lower but not less practical level, they have done much, by means of their technical schools, to provide that very instruction of which, as everyone admits, our artisans are so much in need to enable them to carry on the struggle for existence against foreign rivals. Nor does the Master overstate the advantages which the town indirectly derives from the presence of these colleges, whose teaching staff do much to raise the tone of social life throughout the district. It is a sound argument of the defenders of the Church Establishment that it is a great gain to English society to have at least one educated gentleman settled in every parish. The argument may be extended in favour of the University Colleges, and we may say that in a large town, where the pursuit of wealth through commerce is the characteristic of the whole society, it is a great advantage to have four or five men of high intellectual training, whose aims are different, whose standard is different, and who represent science and literature sometimes with great distinction. It would on many grounds be matter for extreme regret if the excellent institutions which foster such men should disappear. Yet there is too much reason to fear that such will be the fate of most of them, unless help more permanent and certain than any that can be derived from voluntary sources is at once forthcoming. Neither Leeds, Newcastle, Sheffield, Nottingham, nor Bristol is in a satisfactory financial condition. The fees cannot pay even the very modest stipends of the professors, and the annual subscriptions are showing a lamentable tendency to diminish. It seems as though there was nothing for it but an appeal to the Exchequer, sorely tried as it now