

The author then extends his experiments to lead, a metal known to contract greatly in solidifying, and, with respect to which, no one has suggested that it expands at the moment of consolidation. He finds that pieces of lead having a specific gravity of 11.361, and being at 70° F., float or sink upon molten lead of the same quality, whose calculated specific gravity was 11.07, according to the relation that subsists between the volume and the "effective" surface of the solid piece, thin pieces with large surface always floating, and *vice versâ*. An explanation is offered of the true cause of the ascending and descending currents observed in very large "ladles" of liquid cast iron, as stated by Messrs. Nasmyth and Carpenter. The facts are shown to be in accordance with those above mentioned, and when rightly interpreted to be at variance with the views of these authors.

Lastly, the author proceeds to examine the statements made by these writers, as to the floating of lumps of solidified iron furnace-slag upon the same when in a molten state; he examines the conditions of the alleged facts, and refers to his own experiments upon the total contraction of such slags, made at Barrow Iron-works (a full account of which he has given in his paper on "The true Nature and Origin of Volcanic Heat and Energy," printed in Phil. Trans. 1873), as conclusively proving that such slags are not denser in the molten than in the solid state, and that the floating referred to is due to other causes. The author returns thanks to several persons for facilities liberally afforded him in making these experiments.

IV. "Note on the Excitation of the Surface of the Cerebral Hemispheres by Induced Currents." By J. BURDON SANDERSON, M.D., F.R.S., Professor of Practical Physiology in University College, London. Received April 30, 1874.

In a paper recently communicated to the Royal Society by Dr. Ferrier (Proceedings, No. 151) it is shown that when two ends of copper wire distant from each other not more than a couple of millimetres, and in metallic communication with the terminals of the secondary coil of a Du Bois's induction-apparatus in action, are applied to certain spots of the surface of either hemisphere, and great intensity is given to the induced currents thereby directed through the living tissue, by previously bringing the secondary coil into such a position that it is very close to the primary coil or even partially covers it, characteristic combined movements of the opposite side of the body are produced.

With reference to these effects, it was observed by Dr. Ferrier (1) that excitation of the same spot always produces the same movement in the same animal, (2) that the area of excitability for any given movement (or, as it may be called for shortness, *the active spot*) is extremely small and admits of very accurate definition, and (3) that in different animals

excitations of anatomically corresponding spots produce similar or corresponding results. From these remarkable facts and from others similar to them relating to other parts of the brain to which I do not now advert, it was inferred that, at the surface of the hemispheres, certain "centres" are to be found, of which it is the function to originate combined or even purposive movements.

To this inference objections have been recently raised by Dr. Dupuy, based on the results of experiments made by him, in which he found that, after the ablation of those parts of the hemispheres which contain the supposed centres, movements, similar to those described by Dr. Ferrier, can still be produced by electrical excitation of the cut surface. In commenting on these counter experiments, Dr. Ferrier has since pointed out that the effects described by Dr. Dupuy are entirely different from those observed by himself, and, particularly, that the movements produced in his experiments are of an uncertain character, affecting sometimes one, sometimes several groups of muscles.

As it appeared to me that, although Dr. Dupuy has failed to prove that the movements he described are of the same nature with those described by Dr. Ferrier, the latter has not proved that they are different, I thought it necessary to make a series of experiments for the purpose of clearing up this uncertainty. With this view I determined to investigate the most characteristic of the combined movements, so accurately described by Dr. Ferrier as produced by excitation of particular spots on the anterior part of either hemisphere, by comparing them with those produced by excitation of deeper parts. The results of my experiments, in which cats were employed, are as follows:—

1. By removing the integument, skull, and dura mater to an extent corresponding to the anterior half of the right parietal bone and the adjoining thin portion of the frontal bone, an area of the surface of the brain is brought into view which comprises several spots by the excitation of which the following characteristic movements can be produced:—(1) Retraction of the left fore paw, with flexion of the carpus, accompanied by similar movements of the left hind leg. (2) Closure of the left eye and elevation of the left upper lip. (3) Retraction of the left ear. (4) Rotation of the head to the left side.

The active spots for these several movements are as follows:—For (1), a point immediately behind the outer end of the crucial sulcus; for (2), the surface about the outer end of a sulcus which lies immediately behind (1); for (3), the surface behind the sulcus last mentioned; for (4), a spot about a centim. further back on the same convolution. Movements (1), (2), and (3) can be produced in the cat with very great certainty, and the active spots for them are well defined. Their limits and relations are in exact accordance with the statements of Dr. Ferrier.

2. If that part of the surface of the right hemisphere which comprises the active spots above mentioned is severed from the deeper parts by a

nearly horizontal incision made with a thin-bladed knife, and the instrument is at once withdrawn, without dislocation of the severed part, and the excitation of the active spots thereupon repeated, the result is the same as when the surface of the uninjured organ is acted upon.

If a similar incision is made in a parallel plane, but at a lower level, this is not the case; but on removing the flap and applying the electrodes to the cut surface, it is found that there are on it active spots, which, as regards the effect of excitation, have the same properties as the active spots previously observed on the natural surface, and that the latter have the same topographical relation to each other as the former.

3. In a brain hardened in alcohol a needle plunged vertically, *i. e.* at right angles to the surface, from the active spot for retraction of the opposite ear, reaches the posterior part of the *corpus striatum* at a depth of from 10 to 12 millims. If a horizontal incision is made in the living brain, at this depth, and is met by two others, of which one is directed antero-posteriorly and the other transversely, and the part comprised within the incisions removed, a surface of brain is exposed in the deepest part of the wound which corresponds to the outer and upper part of the *corpus striatum*\*. If now the electrodes are applied to this surface, the movements (1), (2), (3) are produced in the same way as before, but more distinctly; the active spots are quite as strictly localized, and their relations to each other are the same as at the surface—the spot for the movement of the extremities being in front, that for the closure of the eye and retraction of the upper lip being to the outside, and that for the ear behind.

From these facts it appears that the superficial convolutions do not contain organs which are essential to the production of the combinations of muscular movements now in question. They further make it probable that the doctrine hitherto accepted by physiologists, that the centres for such movements are to be found in the masses of grey matter which lie in the floor and outer wall of each lateral ventricle, is true.

\* In case it should be necessary to repeat this experiment, it will be found best (after having noted the effects of exciting the surface at the several active spots and ascertained the degree of excitation required for the production of the corresponding movements) to proceed to remove the part of the brain containing them, so as to expose the outer aspect of the anterior part of the *corpus striatum* at once; and then, as soon as hæmorrhage has ceased, to investigate the relative positions of the active spots on the surface so exposed. [Since the above paper was communicated, I have ascertained that at the lowest part of this surface there is a spot, of which excitation induces opening of the mouth and alternate protrusion and retraction of the tongue—a group of movements which Dr. Ferrier has localized on the under surface of the brain, in front of the Sylvian fissure.—J. B. S., June 3, 1874.]