state in the elongation experiments as in the magnetisation experiments. The change of length of the wire was magnified and measured by causing a lever, whose arms were in a great ratio, to deflect a mirror which was observed by means of a telescope and scale at a considerable distance.

The observed change of length was always a contraction. The change of length calculated from the theory of stresses was also always a contraction, the preponderating term $\frac{1}{2}H\frac{\delta I}{\delta P}$ being always negative.

The difference between the observed and calculated contractions was, however, considerable, the theory only accounting for a part of the observed contraction.

Diagrams are given showing the values of the magnetisation, of the effect of increase of tension on magnetisation, and of the observed and calculated contractions, all as functions of the field H.

It was found that the difference between the observed and calculated contractions was approximately proportional to the fourth power of the magnetisation, a diagram showing that, if this corrected contraction be represented as a function of I^4, the points all lie very near a straight line passing through the origin, the deviations being within the limits of experimental error.

"On the Relations between the Cerebellar and other Centres (namely Cerebral and Spinal) with especial Reference to the Action of Antagonistic Muscles. (Preliminary Account.)"

By Max Löwenthal, M.D. (Würz.), M.R.C.P., and Victor Horsley, F.R.S., F.R.C.S. Received February 8,—Read February 25, 1897.

(From the Laboratory of Chemical Pathology in University College, London.)

The following is a brief summary of certain results which we have obtained in the investigation of the relations prevailing between the cerebellum and other parts of the nervous system, and which we commenced in consequence of an observation made by one of us (L), on the 24th May, 1895.

This consisted in the observation that when both cerebral hemispheres were removed and, as a result, active extension tonus* of the limbs was obtained, excitation (faradic) of the upper surface of the cerebellum caused immediate relaxation of such tonus so long as

* We venture to propose the term "acerebral" tonus for the phenomenon, to avoid unnecessary periphrasis, and to distinguish it from that observed after removal of the cerebellar hemispheres.

the current was applied, and that on the latter being shut off the tonus was immediately re-established.

As this observation appeared to indicate a distinct relation between the cerebellum and the bulbospinal system of lower centres, it was obviously very important to examine it further, especially as to whether it was a truly central effect or not.

It was soon made clear that the effect was a constant one, provided that the above mentioned tonus was distinctly established, and further that the primary effect of excitation of the cerebellum upon the upper limb in such case was not an active relaxation of the triceps alone, but that there was a marked contraction of the biceps.

Further, this effect, though constant, when tonus is present, was not the character of the muscle changes obtained when the tonus was absent.

It was, therefore, necessary to arrange a large series of experiments to determine a comparison between the changes in the two groups of muscles according as to whether the cortex cerebri, corona radiata, crusta, tegmentum, cerebellum, or cerebellar peduncles were excited either singly or in combination.

After making fifteen experiments in which the contraction of the muscles involved was determined by inspection, passive movement and palpation only, the movements produced were graphically recorded, and the general conduct of the experiments arranged as follows :—

Method of Experimentation.

The animal (the dog and cat have so far been examined) was anæsthetised by ether, tracheotomy performed for the purposes of convenient anæsthesia and a ligature looped loosely round each common carotid artery. The left sigmoid gyrus, the right occipital lobe and right half of the cerebellum were freely exposed, the dura mater preserved intact, and the whole kept warm by pads of absorbent wool soaked in warm normal saline solution.

The right forearm was next carefully detached at the elbow after the brachial artery had been ligatured, the nerve trunks cut short, and the lower bony insertions of the biceps and brachialis anticus separated from the ulna and radius shafts. A ligature was then attached to these conjointly, and a similar ligature was fastened to the olecranon, which had been detached by a cut through the bottom of the greater sigmoid notch.

The threads securing the muscles were affixed to Fick's spring myographs of suitable strength, and a record thus obtained on paper of the changes in form of the muscles, as well as of the moment and duration of excitation by suitable signals (F. J. Smith's).

The nerve centres were excited in all cases by fine platinum elec-

trodes, 2 mm. apart. The induction coils used were, one on Kronecker's pattern, the other by the Cambridge Scientific Instrument Company.

History of Previous Observations.

The history of previous investigation of the relations of the cerebellum to the other regions of the central nervous system we intend to discuss in a future communication, which will contain the full details of our experiments.

*Synopsis of Results.**

A. *Excitation of the Left "Motor" Cortex*, i.e., *Forelimb Area of the Sigmoid Gyrus of the Left Hemisphere.*

In the dog and cat excitation of the forelimb area of the excitable cortex produced out of fourteen experiments invariably synchronous contraction of both biceps and triceps muscles. The degree of contraction also was remarkably symmetrical, and in the majority of cases even the relative degree of tonus and clonus respectively was constant.

Further, when quasi-purposive reflex (?) movements occurred during alterations in the anæsthesia, &c., this symmetry was even more pronounced.

So far as antagonism is concerned, when the cortex alone was excited, no relaxation of either the biceps or triceps was observed. It will be remembered that these results are purely those obtained from carnivorous animals.

B. *Excitation of the Left Corona Radiata.*

Stimulation of the corona radiata produced in eight cases invariably symmetrical and synchronous contraction of both biceps and triceps. This was an absolutely constant result in all the cases examined. No relaxation was ever obtained.

C. *Excitation of the Crusta of the Left Crus Cerebri.*

In sixteen experiments the crura were excited on the cut surface. The excision of the cerebral hemispheres was always performed by ligaturing both common carotid arteries, and then dividing the mesencephalon by a single incision passing through, or just in front of, the anterior corpora quadrigemina.

* It is to be remembered that the muscles prepared for graphic record were in all experiments the biceps and brachialis anticus and the triceps, of the *right* side only.

In all the experiments the excitation was performed before the general tonus was established, as well as after in the instances where the tonus actually occurred.

(*a*) *Excitation of the left Crusta before General Tonus is established.*—When the crusta was stimulated in the absence of tonus there resulted invariably contraction of both the biceps and triceps.

(*b*) *Excitation of the left Crusta after General Tonus is established.*—When the "acerebral" tonus is established. Excitation of the left crusta produced out of the sixteen experiments :—

In 13 cases	contraction	of biceps	and	contraction	of triceps.	
,, 2	,,	,,	,,	relaxation	,,	
,, 1	,,	relaxation	,,	contraction	,,	

In his most recent communication* on the subject of antagonistic muscle action, Sherrington states that he has obtained cessation of the "acerebral" triceps tonic contraction by excitation of the crus pyramidal fibres. As he does not state how often he observed this effect, we cannot compare the conditions of the two sets of experiments.

D. *Excitation of the Crusta of the right Crus Cerebri.*

The right crusta was also excited in eight experiments, and it was found that, as a rule, there was evoked contraction in both biceps and triceps, but twice relaxation of the biceps and once of the triceps was observed.

E. *Excitation of the Tegmentum of the left Crus Cerebri.*

The surface of the tegmentum was excited, and an effect upon the biceps and triceps observed when the stimulation was applied to the region of the red nucleus and the locus niger. Excitation of the anterior corpora quadrigemina was without effect.

In every case in which the left tegmentum was excited it evoked contraction of both biceps and triceps.

F. *Excitation of the Tegmentum of the right Crus Cerebri.*

The right tegmentum, when stimulated in five cases, gave always contraction of both muscles, as a rule, the triceps being in excess of the biceps, but this was reversed on two occasions.

G. *Excitation of the Cerebellum.*

Excitation of the cerebellum produced very constant and sharply marked effects according as to whether the "acerebral" tonus was

* 'Roy. Soc. Proc.,' January 21, 1897.

present or not, and, further, a notable difference according to the side of the cerebellum excited.

The limits of the excitable region of the cerebellum will not now be discussed, but we may here state that the most excitable area is along the line of junction of the vermis superior with the lateral lobe. (This, it will be noted, is that portion of the cortex of the cerebellum which, in vertical position, is nearest the superior cerebellar peduncle.)

For the purposes of the present communication excitation of the cerebellum means excitation of this focal area.

(a) *Excitation of the Cerebellum when "acerebral" Tonus is established.*—The effect of excitation of the cerebellum when ablation of the cerebral hemispheres has produced general tonic contraction, in extension of the trunk and limb muscles is a striking and *constant* active relaxation so far as the triceps (of the side stimulated) is concerned, and an active contraction of the biceps.

In the absence of graphic record it is impossible to determine precisely what is the nature of this effect on either the biceps or triceps.

We have, however, proved by the graphic method that—

(1) The biceps contracts powerfully;

(2) The triceps actively relaxes, *i.e.*, it does not simply relax by ceasing to contract, but it relaxes so as to lose its normal physiological tonus.

The next step was of course the further investigation whether this phenomenon is unilateral. We have found as the result of twenty-nine experiments that the muscles of the right arm can be influenced by excitation of both halves of the cerebellum, but that the effect is very much greater from excitation of the right half, *i.e.*, the same side. In addition we have excited the two halves of the cerebellum after median division of the organ, and then found that the effect was practically limited to the same side.

This is of course in harmony with the results of ablation of the cerebellar hemispheres obtained by Luciani, Risien Russell, and Ferrier and Turner.

In five experiments it was interesting to find that excitation of the *left* half of the cerebellum, *i.e.*, that of the opposite side, evoked relaxation of the *biceps*. This crossed effect we noticed early in the investigation, and the similarity in the movements of the forelimb in walking was very striking.

The phenomenon of relaxation of the triceps and contraction of the biceps can be obtained also by excitation of the sub-cortical white substance of the cerebellum and of the peduncles in part.

(b) *Excitation of the Cerebellum when no "acerebral" Tonus is yet*

established.—We have constantly obtained from the cerebellar cortex a tonic *contraction* of either the triceps or biceps, or both together, if the "acerebral" tonus had not appeared.

H. *Synchronous Excitation of the Cerebellum and Cerebrum.*

Synchronous excitation of the cerebral area for the forelimb and the cerebellar focus has given so far, in cases where the cerebellum is definitely excitable, an addition to the tonus elicited previously from the cortex cerebri.

While such reinforcement seems to be the rule, we believe that the clonic *character* of the cortical impulses is adversely affected by the cerebellar activity.

Since Professor Sherrington's third note on "Reciprocal Innervation of Antagonistic Muscles" appeared, we have investigated the question of *reflex* inhibition of the "acerebral" tonus by the graphic method, to see how far the two effects are identical, and have obtained some instructive results, the full discussion of which, however, must be postponed, as the observations are incomplete. It is sufficient now to say that while we have confirmed Professor Sherrington's discovery that excitation of an afferent tract on the same (*i.e.*, in our experiments, *right*) side causes relaxation of the triceps and contraction of the biceps, we have also found that excitation of a *left* afferent tract causes relaxation of the biceps and contraction of the triceps, an interesting correspondence with the alternation we observed in the two halves of the cerebellum, and which is obviously related to the movement of progression.

"On the Action of Light on Diastase and its Biological Significance." By J. Reynolds Green, Sc.D., F.R.S., Professor of Botany to the Pharmaceutical Society of Great Britain. Received January 28,—Read February 25, 1897.

(Abstract.)

According to the observations of Brown and Morris,* the quantity of diastase in foliage leaves undergoes considerable variations during the twenty-four hours of the day, being greatest in the early morning and least in the evening, particularly after several hours' sunshine. During the past three years the author has carried out a series of experiments to ascertain whether the diminution in quantity is due to a destructive influence of the light upon the enzyme, similar to

* 'Jour. Chem. Soc.,' May, 1893.