NOTE ON THE MOVEMENTS OF THE TONGUE FROM STIMULATION OF THE TWELFTH NUCLEUS, ROOT, AND NERVE.

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DURING the winter of 1907-8 it was my privilege to be associated with Sir V. Horsley in an investigation into the functions of the inferior olive.

To reach this important group of cells it was necessary for the stimulating needle to pass through the fibres of the twelfth root, and we frequently observed that while stimulation of some of these fibres caused the tongue to protrude to the right, stimulation of other fibres of the same root produced a strong protrusion of the tongue to the left.

In the course of my investigations, which have been continued at McGill during the past year, I have always been puzzled by this protrusion of the tongue to the *left* on stimulating the left twelfth root, for it is generally understood when the tongue is protruded from the left side of the mouth, or into the left cheek, that this movement is due principally to the protruding action of the right half of the tongue assisted by the contraction of the left half [1].

The purpose of this paper is to show that the protrusion of the tongue from the left side of the mouth, and the protrusion of the tongue into the left cheek, may be accomplished by the muscles of the left half of the tongue alone without any assistance from the right half.

In these experiments Dr. Clarke's stereotaxic instrument [3] has been employed. The animal was deeply anæsthetized and the instrument adjusted. The medulla was exposed from the foramen magnum to a few millimetres below the superior border of the atlas so as to have free access for the needle to the twelfth nucleus and root. The movements of the tongue were observed on stimulating (1) the twelfth nucleus, (2) the root in its course through the medulla, and (3) the twelfth nerve in the neck.

On stimulating the left twelfth nucleus (*mutatis mutandis* the same is true of stimulation of the right nucleus), the following movements were observed :—

The tongue was protruded to the opposite side (right); the tongue was curled upwards and over to the right canine tooth. But the most unexpected reaction was a strong protrusion of the tongue from the mouth on the left side.

When the left twelfth root in the medulla was stimulated, similar movements were produced. The tongue was curled upwards and to the right or opposite canine tooth, while stimulation of other fibres caused the tongue to protrude from the angle of the mouth *on the same (left) side*.

The most frequent reaction on stimulating the (left) twelfth nerve in the neck was *a strong protrusion of the tongue out of the mouth on the same side*. Other reactions were: protrusion with the tip of the tongue strongly to the right or opposite side, and curling up of the tip, now to the right and at other times to the left.

EFFECTS AFTER MEDIAN SAGITTAL SECTION OF THE TONGUE.

To exclude any assistance from the right half of the tongue in these movements, the tongue was then divided into two halves along the raphé and the same parts were again stimulated in the nucleus, root, and nerve.

On *stimulating the left nucleus*, the *left half* was protruded to the *right*; the left half could curl up and over to the right canine with no movement of the right half. On reaching the spot that caused on stimulation a strong protrusion of the tongue to the left, *i.e.*, to the same side, it was interesting to see how this movement was produced, for the left half was retracted in a straight line and the right half was strongly protruded—showing the close association of the two nuclei.

This conjugate action of the two separated halves of the tongue was first described by Beevor and Horsley [2] on stimulating the upper part of the tongue area in the right hemisphere.

Stimulation of the left twelfth root caused the left half to curl up to the opposite (right) canine; stimulation of other fibres produced a strong protrusion of the left half to the right; and on stimulation of this left root in another area, the left half was protruded from the left angle of the mouth while the right half remained motionless.

When the *nerve* was stimulated the movements of the left half of the tongue were the same as those observed before the tongue was divided, but now were performed by the left half only.

It will be noticed that when the tongue was protruded from the left

side on stimulating the *left nucleus*, that this movement was due to the retraction of the left half and the protrusion of the right. But when the *root* or the *nerve* was stimulated the protrusion from the left side was accomplished by the muscles of the left half alone.

Having demonstrated the actions of the tongue in the cat, and feeling that a carnivorous animal was probably not suitable for comparison with man, I concluded this investigation by repeating these experiments on a bonnet monkey.

The twelfth nucleus, root, and nerve were stimulated, first with the tongue in a normal state, and then after dividing it into two halves.

All the movements corresponded with those found in the cat and may be summarized as follows :—

(1) The half of the tongue that is stimulated can be protruded to the opposite side as far as the canine teeth.

(2) Can be protruded straight.

(3) Can be protruded from the same side.

(4) Can be protruded into the cheek of the same side.

(5) The tip of the tongue can touch the teeth and gums of the upper and lower jaw on the same side, and as far as the canine teeth, upper and lower, on the opposite side.

(6) The tip of the tongue can curl upwards and backwards to the roof of the mouth on the same side.

In fact, it was clearly demonstrated that the only movements that the stimulated half of the tongue could *not* perform were : protrusion from the opposite angle of the mouth, protrusion into the opposite cheek, as well as the inability to touch the molar teeth and the gums on the opposite side.

Therefore, these experiments show that when one half of the tongue is paralysed from affection of nucleus, root, or nerve, the following symptoms are observed :—

Inability to touch the teeth, the gums, or to protrude the tongue into the cheek of the paralysed side, while there is perfect freedom of movement to the sound side, the tongue being easily protruded into the cheek of this side and the teeth and gums being readily touched ; in advanced cases secondary atrophic changes in the paralysed half may, however, greatly interfere with the movements of the sound half.

REFERENCES.

- [1] BEEVOR. *Brain*, 1906, p. 487.
- [2] BEEVOR and HORSLEY. *Phil. Trans. Royal Society*, 1894, vol. 185, p. 56.
- [3] HORSLEY and CLARKE. *Brain*, 1908, vol. xxxi., p. 1.