On the position of the motor centres in the brain in regard to the nutritive and social functions / by T. Lauder Brunton.

[*Reprinted from* 'BRAIN,' *Part XVI.*] IV. 1882

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ON THE POSITION OF THE MOTOR CENTRES IN THE BRAIN IN REGARD TO THE NUTRITIVE AND SOCIAL FUNCTIONS.

BY T. LAUDER BRUNTON, M.D., F.R.S.

IN one pregnant sentence the German philosopher Goethe sums up the essence of human action. "Warum treibt das Volk so und schreit? Es will sich ernähren, Kinder zeugen, und sie ernähren wie es vermag." (Why are people so busy, and what are they roaring about? They want to feed themselves, to beget children, and feed them as best they can.) In these three reasons for human activity we find that one is personal and that two are social. The first of these is the personal one, the duty of the individual to himself. The second and third are the social ones, the duties of the individual to society. The clear insight of the philosopher led him rightly to put the duty of the individual to himself first. Under certain conditions we find that the social may overpower the personal instincts, even in the lower animals, and lead the mother to sacrifice her own life in trying to save her progeny. In certain exceptional instances we find the social instinct extending beyond the circle of immediate blood-relations, and inducing a man, as in the well-known story of Damon and Pythias, to sacrifice his life for that of his friends, or even inducing him, like Sir Philip Sydney, to refuse the water which was offered to quench his own burning thirst, and give it to an utter stranger simply because he believed the other to need it more. Such instances as these do occur; but the care with

which they are recorded, and the admiration with which they are regarded, clearly show how exceptional is their occurrence. The instinct of self-preservation is one which underlies, and, except in the very rarest cases, is more prominent than the social instincts. It may sometimes be brought out only in the utmost need; but when the survivors of a shipwreck are struggling for the last particle of food on board a raft, or for the last drop of water in the midst of the Sahara, or for a breath of air in the Black Hole of Calcutta, then the instinct of the individual to preserve himself, whatever may be the cost to others, makes itself manifest. The instinct of self-preservation, indeed, must be the fundamental one, for otherwise the evolution of the races of animals now living would have been impossible. Animals not having this instinct of self-preservation would necessarily have perished in the struggle for existence, and those endowed with it would have succeeded. The fundamental acts of self-preservation are the respiration of air and the acquisition of food. Respiration is a simple act, and, as the air is everywhere around us, very simple rhythmical movements are sufficient to carry it on. These movements, too, require no further development during life, and the respiration of the newly-born child is as perfect as that of the full-grown man, as far, at least, as the aeration of the blood is concerned. No doubt the adult learns to modify his respiratory acts for such purposes as singing and speaking, and the nerve-centres by which these modifications are affected are capable of gradual development by careful training. They are no doubt to be sought in the cerebrum, but the nervous centre through which the mere aeration of the blood is effected co-ordinates very simple movements only, requires little or no further development, and is situated in the medulla oblongata and upper part of the spinal cord. The centres by which the primary acts of nutrition, deglutition, digestion, &c., are effected, are also situated in the spinal cord and in the sympathetic ganglia, for an anencephalous infant will suck, and a pigeon deprived of its brain will swallow the grains of corn placed in its beak, but they are unable to seek their food. The centres by which the more complicated acts required in order to obtain food are, no doubt, situated in the brain.

Hence the anencephalous infant, or the animal deprived of its brain, are unable to seek food for themselves, although they may swallow it when it is placed within their mouths. Modifications of respiration in producing voice, although exceedingly important for men and animals in their social relations, are comparatively unimportant for the nutrition of the individual, whereas the movements for seeking and obtaining food are essential to its existence. We should therefore expect that the motor centres in the brain would be arranged chiefly with reference to the aequisition of food, and that the centres would be modified in different animals according to the manner in which they obtained their food. That this is really the case appears, I think, from an examination of the functions of the motor centres of the brain as ascertained by Ferrier:

1. The eyes open widely, the pupils dilate, and head and eyes turn towards opposite side.

2. The opposite arm and hand extend forward as if to reach or touch something in front.

3. The opposite arm is retracted and adducted, the palm of the hand being directed backwards.

4. The fore-arm is supinated and flexed, so as to raise the hand to the mouth.

5. The angle of the mouth is retracted and elevated.

6. The ala of the nose and the upper lip are elevated, and the lower lip is depressed, so as to expose the canine teeth on the opposite side.

7, 8. The mouth is opened and the tongue protruded and retracted. The mouth is alternately opened and closed, and the tongue moves. The movements here are distinctly carried out bilaterally.

9. The opposite angle of the mouth is retracted, the platysma myoides is thrown into action, and when this is powerful the head is drawn slightly to the side.

(*a*), (*b*), (*c*), (*d*). Individual and combined movements of the fingers and wrist, ending in clenching of the fist. Centres for the extensors and flexors of the individual digits could not be differentiated, but the prehensile movements of the opposite hand are evidently centralised here.

10. Advance of the opposite hind limbs, as in walking.

11. Complex movements of the thigh, leg, and foot, with adducted movements of the trunk.

12. Movements of the tail, associated with some of the last movements.

If we look at the accompanying diagram, copied from Ferrier's work, with an alteration in the numbers by which he designates the different centres, we see that in the monkey the centres appear to lie around the fissure of Rolando in a definite order, corresponding to that which would be necessary for the animal to obtain food. Taking the centres in the order in which we have numbered them, we find that, when they are successively irritated, the sequence of movements is as follows:—that the eyes open widely, the pupils dilate, and the head turns as if to look for food. Next the hand and arm are extended as if to take it. The arm and hand are next retracted and adducted. Next, the hand is supinated and the fore-arm flexed, so as to bring the hand towards the mouth, as if to convey food into it. Next, the angle of the mouth is retracted and elevated, the canine teeth are exposed, the mouth is opened, the tongue retracted and protruded, and the mouth alternately opened and closed with movements of the tongue as during mastication. There is next retraction of the opposite angle of the mouth, with powerful contraction of the platysma myoides. I do not know whether this has any connection with the emptying of the cheek pouches in the monkey, but it is certainly an accessory act in mastication and deglutition. It is not observable in man under ordinary circumstances, but it at once becomes evident when deglutition is rendered difficult by sore throat and tonsillitis. A similar action is also noticed in man when powerful movements of the jaws are required, as in cracking a hard nut.

The next movements (*a*), (*b*), (*c*), (*d*), are complicated movements of the hand, which have not been more particularly analysed. Complicated movements of the hand are certainly required in frugivorous animals such as monkeys, in order to separate the edible parts of their food, as, for example, to pick out the kernel from a nut which they have just cracked. The centres are absent in the dog, where no such movements are wanted.

FIG. 1.

1. The eyes open widely, the pupils dilate, and head and eyes turn towards opposite side.

2. Extension forward of the opposite arm and hand, as if to reach something in front.

3. Movements of tail (and trunk).

4. Retraction with adduction of opposite arm.

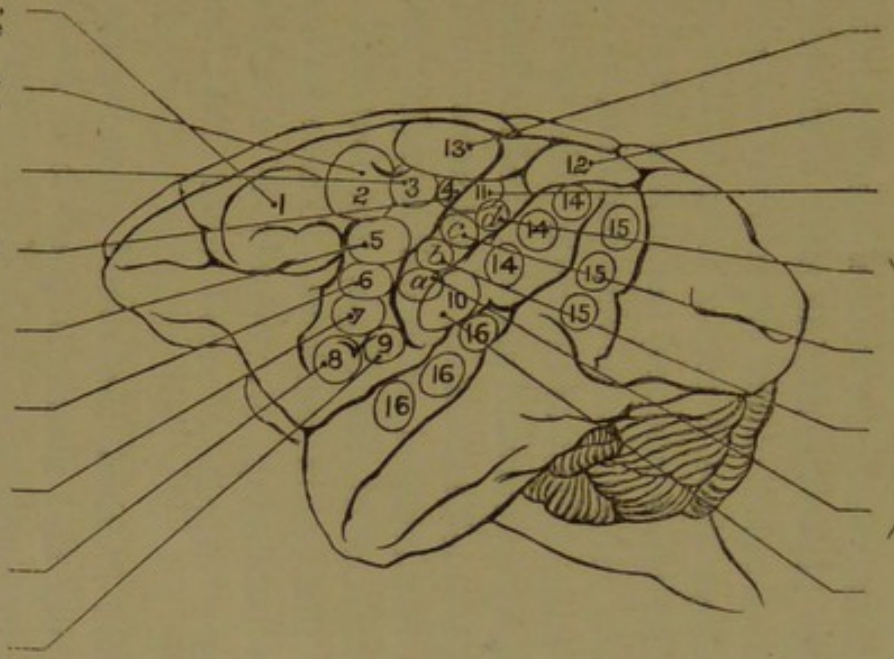
5. Supination and flexion of the fore-arm, by which the arm is raised towards the mouth.

6. Action of zygomatics, by which the angle of mouth is retracted and elevated.

7. Elevation of ala of nose and upper lip.

8. Opening of mouth with protrusion of tongue.

9. Retraction of tongue.



13. Complex movements of thigh, leg and foot.

12. Advance of the opposite hind limb.

11. Retraction and adduction of opposite arm.

a, *b*, *c*, *d*. Prehensile movements.

10. Retraction of opposite angle of mouth.

BRAIN OF MONKEY.

The next movement is that of retraction and adduction, and is the same as that which has already been noticed as being employed in gathering food. I have numbered the centre for this movement 11, and it is the same as that which I have numbered 4. Ferrier has reckoned these two centres as one. I have, however, taken the liberty of dividing his single centre into two, inasmuch as it extends over the fissures of Rolando, and as it appears to me that this movement, although of the same character, is employed for a double purpose. It seems to me that while the movement of retraction and adduction started by centre No. 4 is for the purpose of gathering food, the same movement is related, when started by centre 11, to the casting away of the refuse portions of food. I have not had an opportunity of observing the habits of monkeys since I began to write this paper, but, so far as my recollection serves me, the movement of the monkey in throwing away refuse is somewhat peculiar, nut-shells being cast by these animals, not to the right side, as they probably would be by us, by an outward movement of the hand, but down to the left by a quick movement of retraction and adduction. Next, the leg is advanced as in walking, (10) and then come complex movements of the thigh, leg, foot, and trunk, with movements of the tail in monkeys. These we may regard as movements of balancing, or possibly of climbing, in order to reach a new supply of food after the first has been consumed.

We have now finished the round of movements necessary for the procuring and masticating of food, and the cycle of movement again commences, with No. 1. On comparing the arrangement of centres in the brain of the dog or jackal with those in the monkey, we are struck by a curious difference. While in the monkey the centres are arranged in the order just mentioned around the fissure of Rolando in unbroken sequence, we observe that in the dog and jackal the centres which are arranged round the crucial sulcus, corresponding to the fissure of Rolando, are few in number, and that the others are situated lower down, on a different convolution. The four centres surrounding the crucial sulcus in the dog, in Fig. 2, are numbered, in Ferrier's experiments, 12, 5, 4,

and 1 respectively, corresponding to the centres numbered, in Fig. 1, 1, 2, 4, and 12 respectively. These centres are those for the direction of the eyes, movement forward of the fore-leg, its retraction and adduction, and advance of the opposite hind limb. These are the movements required for seeing food, and for simple running straight forward in active pursuit of the fleeing animal which is to supply it. The use of the lateral movements of the tail in pursuit is seen in the grey-hound, where the tail aids the animal in guiding its rapid course or in turning; but as it also is not so essential as the movements of the limbs, nor in such constant action, its centre, No. 3, Fig. 2, is placed somewhat aside from the principal gyrus. We see here that the arrangement of the centres in the dog and jackal differs from that in the monkey very much in the way we would expect, for while the monkey, living in trees yielding abundance of fruit, has only to see where the food is hanging and by one or two efforts to reach it, animals of the dog tribe have usually, after seeing their prey, to run for a considerable distance before they can hunt it down, and bring into action the muscles of the mouth and jaws by which they seize and devour it. The centres for sight and for running are, then, arranged in simple order round the crucial sulcus, while those for the movements of the jaws are placed in an adjacent convolution (Fig. 2). In his 'Expression of the Emotions,' Mr. Darwin has noted the action of the muscles of expression in protecting the eye from injury or strain, and one of the points that strikes us most forcibly in the arrangement of the motor centres in the dog is the action of the zygomatics and orbiculares in causing closure of the eyes, this closure being very closely associated with movements of the mouth. I do not know whether wolves or jackals shut their eyes at the moment they fix their fangs in the flesh of their prey, but such a movement as this would seem to be well adapted for the protection of their eyes, either from injury by the animal they attack, or from the effects of the increased tension caused by the muscular efforts in the act of attacking. On looking at the brain of the cat we are struck by the absence of the centre No. 12 in Ferrier's work, corresponding to No. 1 in the diagram in this paper, the centre

FIG. 2.

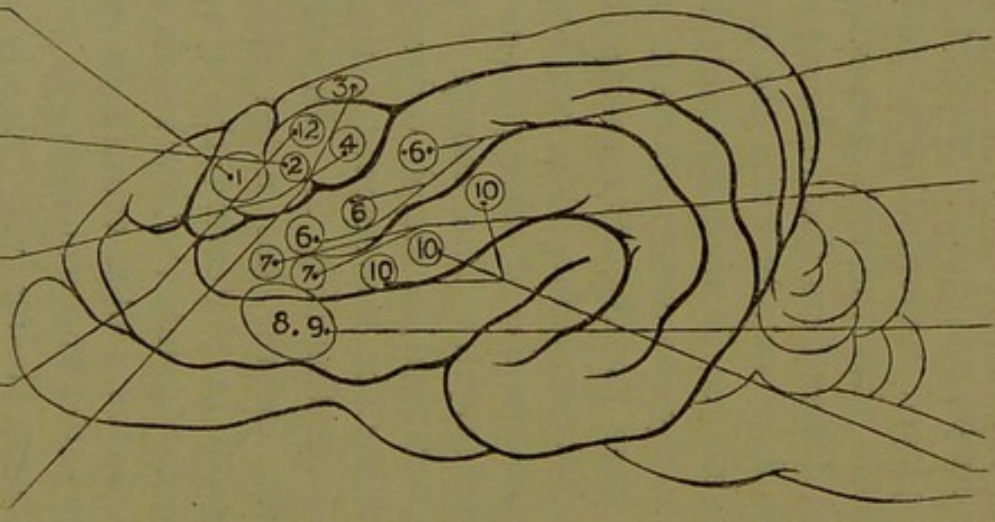
1. The eyes open, the pupils dilate, the eyes and head turn towards the opposite side.

2. The shoulder is elevated the opposite fore-limb extended forwards.

3. The opposite fore-limb is retracted.

4. The opposite hind leg is advanced as in walking.

5. Lateral movements of the tail.



6. Closure of eye.

7. Retraction and elevation of angle of mouth so as partially to open mouth (? snarling movements).

8, 9. The mouth is opened and tongue protruded and retracted (licking movement), sometimes growling.

10. Retraction of angle of mouth from platysma (? crushing bones or swallowing).

BRAIN OF DOG. (The numbers on the centres in the diagram correspond to those in Fig. 1.)

which causes movement of the eyes. At first sight this seems very extraordinary, because the formation of the eyes of the cat is so peculiar that one is accustomed to think that it hunts its prey very much by sight. The want of this centre seems to me to render it probable that the sense of hearing and the tactile sense furnished by the cat's whiskers are considerably more important in directing the animal towards its food than even the sense of sight. We see, also, that the centre 4, for the retraction and adduction of the fore-arm, is much more developed than in the jackal or dog, and this we should conclude from the use which the cat makes of the fore-arm in striking its prey. On looking at the centres in rabbits, guinea-pigs, and rats, we see that they are arranged in the order 2, 4, 12, in this diagram, and 5, 4, 1 in Ferrier, that is to say, extension and retraction of the fore-leg, and forward movement of hind-leg. There is also great extension of the centres for the movements of the mouth, just as one would expect in rodents.

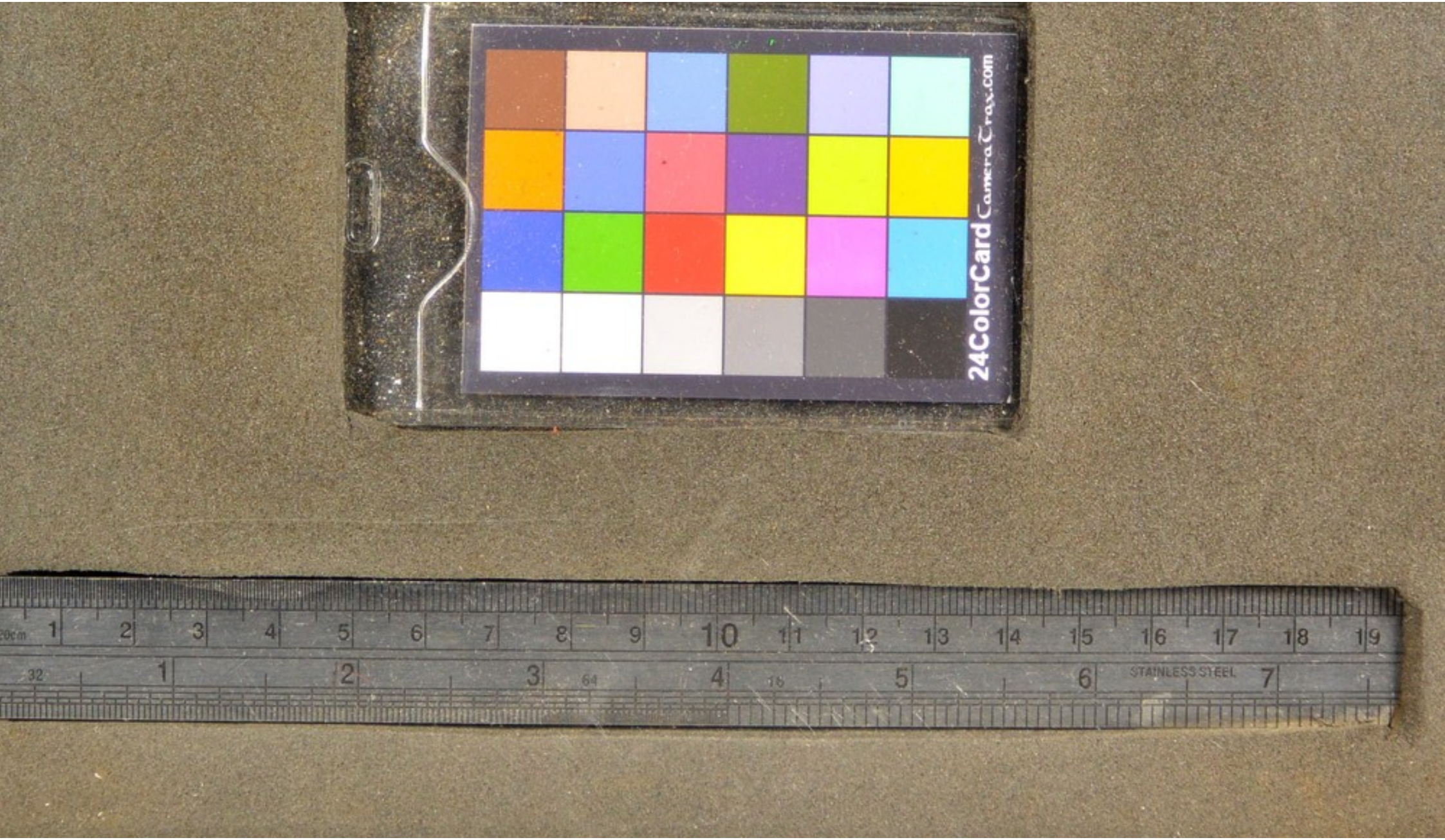
From this arrangement in these different animals it appears, I think, that the motor centres are arranged round the crucial sulcus or fissure of Rolando in such an order as, first of all, to subserve the wants of the animal in obtaining food, the motor centres which are first called into requisition in going after the food being nearest to the fissure, and those which are only required after the first centres have been in action for some time being arranged in an adjoining convolution. The social instincts, and especially the sexual, which is the primary social instinct, are subserved more especially by those modifications of respiration which give rise to voice. We find animals of the cat tribe purring or growling over their food, yet the voice is not of primary importance in obtaining food. Its chief use is that of enabling the animals to communicate with each other. Such communication is no doubt primarily of sexual importance, but it is also useful in enabling animals of the dog tribe, such as wolves, to obtain food by summoning one another to collect together for the purpose of hunting in packs. Although there are some very marked exceptions amongst animals, it is, generally, only after the wants of the individual have been satisfied by food that the sexual

instinct comes into play, and we should therefore expect that the motor centres connected directly or indirectly with it, such as the centres for voice, would be further removed from the crucial sulcus, or fissure of Rolando, than the motor centres required for the obtaining of food. This we find to be actually the case, but I am not at present in possession of sufficient data to enable me to extend my paper to this branch of the subject.

Even should the conclusions at which I have arrived, and which I have here stated, be erroneous, the hypothesis that the motor centres are arranged in the way I have described will enable those who have experienced difficulty in remembering their position to do so with ease, as I have had occasion to observe in the case of students.

For convenience of reference I give here in tabular form the corresponding centres as numbered in Ferrier's work on the Functions of the Brain, and in Figs. 1 and 2 in this paper.

Ferrier.	Figs. 1 and 2.
1	12
2	13
3	3
4	4
5	2
6	5
7	6
8	7
9	8
10	9
11	10
12	1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