Two Lectures

ON THE

PHYSIOLOGY OF THE EMOTIONS.

DELIVERED AT KING'S COLLEGE,

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LECTURE II.

THE PATH OF PAIN IMPULSES IN THE SPINAL CORD.

SCHIFF taught that the grey matter is aesthesodic and the white matter kinesodic. A condition known as syringomyelia, in which the grey matter is destroyed and the white matter uninjured, is characterized by a condition of sensory dissociation. The patient feels tactile sensations, but no longer feels pain, or heat and cold. Sherrington has shown that the impulse of painful impressions coming from one half of the body leaves the grey matter and passes up the lateral column of both sides, rather more on the opposite. The painful stimulus is transmitted to the brain, but there is no certain evidence to show that pain is represented in any part of the cortex.

Painful sensations, together with all afferent sensory stimuli, meet in the optic thalamus, the principal function of which is that of a sensory relay station to the cortex. This mass of grey matter, including the external and internal geniculate bodies and pulvinar, sends afferent radiations to all parts of the cerebral cortex, but particularly to the projection centres about the primary fissures. It contains two forms of cells, large cells like those of the anterior horn of the spinal cord and the motor area of the cortex, and smaller cells. These large cells are in all probability motor in function, and control the subconscious, involuntary, instinctive, automatic, mimic reflexes of gesture, physiognomical expression, and of primitive vocalization. The evidence in favour of this is that experimental lesions in animals and spontaneous lesions in man invariably produce some degree of anaesthesia on the side opposite the lesion. Irritative lesions of the thalamus are frequently associated with severe pain in the opposite half of the body. It is a well known fact, first described by Sir Charles Bell that in old cases of cortical hemiplegia the face on the diseased side can only be imperfectly moved by the will, yet if the patient, under the influence of the emotions, laughs or cries this side of the face is more strongly contracted than the non-paretic side. In lesions of the thalamus, on the other hand, the opposite is frequently observed. The patient, on the one hand, can voluntarily move the paretic side of the face well in all directions, as in showing the teeth, voluntary laughing, etc.; on the other hand, in emotional expressional movements this side of the face is immovable. According to that very reliable observer, von Monakow, this condition is not met with in any other cerebral lesion; therefore, although it does not occur in every lesion of the optic thalamus, yet the fact that it does not occur in other cerebral lesions indicates that some part of the thalamus is associated with these reflex mimetic movements. Monakow, moreover, cites cases which seem to show that it is possible "that secretory, vasomotor and other tracts of fibres in connexion with the sympathetic nervous system have an abundant representation in the thalamus optics."

But let us return to pain, and for argument sake say that pain is produced by a strong excitation transmitted by the grey matter and lateral columns of the spinal cord to the thalamus; here the feeling of pain is produced, but this is always associated with perceptual cortical feeling of localization and cause, with secondary associations of time and space. If pain *per se* were represented in the cortex, then it should be continually revived in memory with the re-representation, but pain is forgotten as soon as it is over, and what we recollect are those intellectual perceptions which will enable us to avoid it in the future.

Stimulation of the cortex of the central convolutions has been performed without anaesthetics in man (Dana); the only effect was a slight numbness and tingling in the extremities, fingers, thumb, etc., not amounting to pain. The brain can be cut without causing pain. Stimulation

of the thalami in animals, in contradistinction to the cortex, gives rise to manifestations of pain. Pain is unknown as an aura in cortical epilepsy, and no region of the cortex has been proved beyond doubt to be associated with pain, although it has been asserted that the gyrus fornicatus is a centre for pain.

Sherrington has shown that in a spinal animal the pain reflex is prepotent. Take, for example, the reflexes which engage all the muscles of the hind limb in purposive movements of a useful character; if a reflex, such as scratching, is set up in the right leg, to remove a stimulus resembling a parasite among the hairs of the front of the body, and, while this scratching is proceeding, a painful stimulus (like a thorn) is applied to the pad of the left foot, a flexor withdrawal occurs, accompanied by a replacement of the right foot to the ground to act as a support. Experiments show that the sexual reflex in the lower animals—for example, frogs and tortoises, etc.—is even more potent than pain reflexes, and Sherrington rightly affirms "that reflexes arising in species of receptors which, considered as sense organs, provoke strongly affective sensations, *ceteris paribus*, prevail over reflexes of other species when in competition with them for the use of the final* common path."

If now we examine the effects of painful stimulation of the skin in a *decerebrate* animal, in which therefore a wider conjunction of reflex arcs is left than in the *spinal* animal, a number of reflexes are obtained which Sherrington terms "pseudo-affective," because the neural mechanism for the perception of pain is cut off from its connexion with the receptor; but it is still in connexion with a purposive instinctive reflex motor mechanism of offence and defence, the action of which is usually considered as the outward expression of the inward affective feeling, and it may be assumed that had the brain been present the feeling would have occurred. Such a *decerebrate* animal, when the sciatic nerve is stimulated, exhibits movements indicative of offence and defence, forward cyclic movements, as in progression, turning of the head toward the part excited, opening of the mouth, retraction of the lips, movements of the jaw as in snapping, movements of vibrissae, lowering of the head, dilatation of the pupils, vocalization angry in tone (sometimes plaintive, sometimes snarling), and with these a passing increase of arterial blood pressure. These movements are ineffective and of brief duration† possibly because they are deprived of the perceptual reinforcement which the brain gives. Sherrington proceeded to ascertain how these pain reflexes can be abolished, in order to establish the probable path of pain reflexes in the cord. The method Woodward and he adopted was to compare by means of the above reaction the effect of two stimuli symmetrically but successively applied on opposite sides of the body after a semisection of the spinal cord or other lesion of the spinal cord headward of the nerve path stimulated. He concludes that each lateral column conveys impulses from both halves of the body, and somewhat preponderantly from the crossed half; and this is true for these arcs, whether they be traced from skin, muscles, or viscera.

Goltz, by a long series of careful and judiciously planned experiments, was able to remove the whole of the cerebral hemispheres and a large part of the basal ganglia from a dog in successive operations, and the animal by patient and careful feeding was kept alive many months, and valuable observations on a *decerebrate* animal were made. Its behaviour as compared with his own normal dog is a most valuable psychophysiological study, and I will briefly describe the more important features of this comparison. The animal would lie curled up like a normal dog, it could be aroused by the loud blowing of a horn, and by blowing through a tube a current of air on to its skin, when it would raise itself on its four legs and shake itself. If the animal had been roused by the blast of the horn it would put its paw up to its ear as if something unpleasant had happened. When the animal was removed from the pen, as it was every day, to be fed, it growled, snapped, and snarled like an

* Sherrington uses this term for nerves to muscles which are employed for the performance of reflex actions under the influence of different stimuli.

† More probably the brief duration is due to the fact that if we regard the whole nervous system as an accumulator of energy, the removal of the greater part of the brain takes away the greater part of the store of energy.

angry brute, and resisted and struggled to be free and return to its cage; it showed, in fact, exactly the same signs of anger as the decerebrated dog whose sciatic nerve was stimulated in Sherrington's experiment: lowering of the head, bristling of the hair, retraction of the ears, and growling, biting, and snapping. Although removal from the cage every day meant to the animal appeasement of hunger, yet this animal every day for eighteen months, until the day of its death under chloroform, gave the same instinctive sign of anger, and never joy, fear, or affection. Goltz compared the behaviour of this animal with the behaviour of his own animal, who would allow him to pull his tail and tread on his foot, showing, however, by his expression that he felt it painful, but he tolerated it and controlled his feelings because of affection for his master. The decerebrate bitch, on the contrary, made no distinction between the stranger and the man who had fed her every day. She had no memory,

Fig. 1.—The muscles of a shark supplied by facial nerve. After Ruge.

but still possessed desires and instinctive reactions. When hungry especially, like the wild animals in the Zoological Gardens, she performed continuous pacing movements of locomotion in one direction from right to left, or the contrary; moreover, she would place her two forepaws on the front of the cage, standing on her hind legs. She could maintain her position on the four limbs on a smooth and sloping surface, and defaecated and urinated like a normal bitch. The expression of the dog was entirely devoid of intelligence, and it did not wag its tail, nor did it ever show signs while asleep of dreaming like other dogs. When fed the food was placed near its muzzle; it then masticated and swallowed it like a normal dog. An interesting experiment was made by Goltz in relation to the emotion of *disgust*. Pieces of meat were soaked in a solution of quinine and given to the animal; it refused to eat the meat. The same pieces were given to the normal dog; it wagged its tail, pulled a face, and looked to its master as much as to say, Well, this is unkind of you to give me this! I don't like it, but to oblige you I will swallow it, which he did upon encouragement. Not even hunger would make the dog without a brain swallow the bitter meat. Now this interesting fact supports Richet's view that bitter and acrid substances which are unpleasant are as a general rule poisonous or noxious, whereas sweet tasting things for which we have a gust (*goût*) are pleasant and beneficial. So that *disgust* (*dégoût*) is protective to the alimentary canal and the vital bodily organs, just as pain protects the external surface of the body. This animal ceased to have oestral periods and never showed the slightest sexual desires. The animal was deprived, however, not only of the cerebral cortex, but also of the basal ganglia, the corpus striatum and the optic thalamus. How it would have behaved had it been possible to destroy the cortex leaving these structures we do not know, but the experiments of Nothnagel, Bechterew and many others rather point to these structures being very important in relation to the emotions, and recently Pagano has published a number of experiments on adult and newborn dogs which I will briefly relate, although I am of opinion that the experiment of injecting fluids such as curare into the basal ganglia, even though controlled by simultaneous coloration by a dye so that the extent of the effect of the irritant can be gauged

on *post-mortem* examination, is not altogether reliable. This experimenter claims to have demonstrated that excitation of the caudate nucleus and of the optic thalamus provokes in adult dogs movements of expression distinctly attributable to determined emotional states accompanied by visceral phenomena. It was, however, important to demonstrate that there was a real functional autonomy; he therefore excited the caudate nucleus in newborn animals. From his experiments he concludes that in the basal ganglia are found at birth the physiological pre-organized mechanisms of emotional reactions. The cerebral cortex not being functional at birth is, therefore, not indispensable for these emotions. He concludes also that the superior psychical centres which are superimposed on the lower centres are only a new source of stimulus for primordial expression, but at the same time the origin of secondary modifications of emotional expressions. He injects 0.1 c.cm. of 2 per cent. solution of curare

Fig. 2.—The muscles of a reptile supplied by facial nerve. After Ruge.

coloured with thionine into various portions of the caudate nucleus. The results obtained are as follows: Excitation of the anterior third and of the middle third of the caudate nucleus, especially in their inner half, provokes the emotional phenomena of fear. They are characterized by the attitude of the body, the physiognomy, the cardiac and respiratory phenomena, intestinal and vesical, the state of the pupils, and menacing noises which exaggerate considerably these manifestations of terror. Excitation of the anterior extremity of the caudate nucleus produces phenomena of psycho-motor agitation of the same kind, and expresses a mingling of the two emotions fear and anger. Excitation of the posterior portion provokes manifestations of anger. Excitation of the anterior third produces erection of the penis almost as strongly as stimulation of the lumbar centre.

Fig. 3.—The muscles of a lower mammal supplied by facial nerve. After Ruge.

Sherrington has performed some notable experiments which show that an animal whose brain has been cut off in its connexion from the heart and viscera generally, still exhibits joy and sorrow, anger and fear, disgust and sexual instinct. He divided the spinal cord in a dog in the lower cervical region, and when the animal had sufficiently recovered from the effects of the operation he cut both pneumogastric nerves. In this way the brain was cut off from any afferent impressions from the viscera, yet the animal showed joy at seeing the attendant who fed him, anger at a stranger, and fear and sorrow when scolded. One animal only 9 weeks old, kennel-fed, was thus operated upon, and when given milk in which pieces of dog flesh had been placed, absolutely refused to touch this flesh under any circumstances and showed marked signs of *disgust*. Sherrington lays particular stress on this experiment as proving that "even the primitive emotions seem to involve perception, seem little other than sense perceptions richly suffused with affective tone." Of course Sherrington himself is aware that these experiments are not conclusive, for although the animals may have expressed emotion in their facial expression and attitude appropriate to the exciting cause, although the viscerovascular and much of the muscular expression was cut off from the sensorium, yet we have no means of knowing the subjective feeling of the animal, and "a small but notable fraction of the latter—namely, the facial, still remained open to react in the centres with which consciousness is colligate." Again, Lloyd Morgan, in con-

nexion with this experiment, states: "The avenues of connexion were (only) closed after the motor and visceral effects had played their part in the genesis of the emotion on the hypothesis that the emotion is thus generated. Although new presentative data of this type were thus excluded, their representative after-effects were not thus excluded." In reply to this criticism, Sherrington remarks:

But it is noteworthy that one of the dogs under observation had been thus experimented upon when only 9 weeks old. Disgust for dog's flesh could hardly arise from the experience of nine weeks of puppyhood in the kennel.

Now this aversion to dog's flesh was due to olfactory impressions, and that "dog will not eat dog" may, in the long procession of the ages, have led to the establishment of a preorganized mechanism by which disgust at dog's flesh might occur reflexly in the medulla; the paths of smell and taste were still open, and the only means the dog had of showing aversion it exhibited. We see that Goltz's dog exhibited disgust at meat soaked in quinine, although the gustatory cortical centres could not have been acting.

Newborn animals are excited to the complex act of

correspondence with changes of structure which the organ of breathing undergoes in the course of development in animals. Not until we arrive at the fishes, the lowest of the vertebrates, do we find the mouth connected with the organ of respiration. In the reptiles nostrils appear, and in the mammals lips, and for the better adaptation to environment as we ascend the scale of vertebrates we find a progressive reciprocal simultaneity of development in the circulatory, nutritive, and respiratory systems and the neural mechanism for their associated action. As Bell says, there is a remarkable consent between the muscles of deglutition and respiration.

Our present knowledge of comparative anatomy of the nervous system tells us the truth of Bell's remarkable foresight and philosophic deductions. Dr. Ariens Kappers, in a most interesting paper on the phylogenetic disposition of the motor cranial nuclei and the structure of the autonomous sympathetic system, points out that in fishes the seventh nerve innervates the constrictors and a muscle termed the "adductor mandibuli," which we find again in the higher animals as the posterior belly of the digastric. The constrictor group of muscles is supplied by a group of visceromotor cells which acquire

Fig. 4.—Diagram of muscles of face, from Sir C. Bell. A, Occipitofrontalis. B, Corrugator supercilii. C, Orbicularis palpebrarum. D, Pyramidalis nasi. E, Levator labii superioris alaeque. F, Levator labii proprius. G, Zygomatic. H, Malaris. K, Triangularis oris. L, Quadratus menti. M, Risorius.

Fig. 5.—Diagram from Henle. A, Occipitofrontalis. B, Corrugator supercilii. C, Orbicularis palpebrarum. D, Pyramidalis nasi. E, Levator labii superioris alaeque. F, Levator labii proprius. G, Zygomatic.

sucking and pressing forward the forelimbs, and it is said that the stimulus is smell, for such are not performed if the olfactory nerves of a puppy are destroyed. Moreover, anencephalous monsters cry and show signs of pain and desire for food, and they are capable of the complex acts of sucking and crying without any cerebrum. There must, therefore, be a preorganized mechanism for crying and sucking in the base of the brain. In mammals the lips and the muscles of the lips have been primarily developed for the purpose of sucking, the nostrils and the muscles that act on the nostrils for the purpose of breathing during the act of sucking. The senses of the young mammal require to be educated in order to be able to adapt itself to its environment, consequently it is for a time helpless and dependent upon its mother for nutrition and protection. But the mother must leave it to seek food, consequently the offspring requires a means of calling for her help to satisfy the needs of hunger or for protection; thereby has been evolved a preorganized nervous mechanism for crying which involves the integration of even a larger number of neurones than the act of sucking. Now, Sir Charles Bell showed that the respiratory nerves form a superadded system introduced in the higher animals in

as we ascend the animal scale a secondary somatic importance. The great sphincter of the neck in reptiles and birds owing to the more complex arrangement of respiration is developed in mammals into the great group of muscles of the neck and face (vide Figs. 1, 2 3). It is therefore the constrictor group which not only increases, but also becomes strongly somatic, in proportion to its function taking part in the life of external relation and less in the life of internal relation. We also see how intimately deglutition is phylogenetically associated with the muscles which express the emotions. As progressive development occurs the nucleus of those facial muscles of expression (phylogenetically of visceral origin) comes more and more under the influence of the will by innervation currents from the psycho-motor cortex; moreover, the centres of swallowing, respiration, vomiting, and all the centres in the bulb are influenced by impulses from the tertiary taste and smell centres from which nervous tracts arise, and wholly or partially terminate in the tegmentum bulbi.

The sensory division of the fifth and the superior laryngeal nerve stand as sentinels to the alimentary and respiratory tracts, and when stimulated by chemical or mechanical agents excite appropriate reflexes for

the preservation of the individual, and these reflexes are instinctive and untaught, but nevertheless involve an associated co-order in vast systems of efferent motor neurones in the bulb and cord; inhibition of one group, impulsion to another, according to the purpose required; the same groups of neurones thereby bringing about entirely different actions according to the nature of the stimulus, just as we know occurs in the purposive spinal reflexes, only in a more complex way. But this can only be accounted for in the case of sucking, crying, laughing, and the expression of the primitive emotions, as witnessed in animals, children, and all races of men, by accepting Darwin's theory of the evolution and transmission of an associated habit serving some useful purpose in the preservation of the individual or the species. But integrative action or co-ordination, as Sherrington's important experiments on the spinal animals show, is effected by neurones of association linking up the spinal motor neurones in such a way that they discharge or inhibit innervation currents from the spinal motor neurones to groups of antagonistic muscles in such a way that the action in response to the stimulus is most appropriate for the preservation of the animal or the species. In other words, in response to all stimuli which are of fundamental importance to the life of the individual or the preservation of the species, nervous force will always tend to flow along the path formed by associated habit ancestrally innate, and therefore stable, by a transmitted preorganized mechanism. Darwin, aided by the investigations of Donders, supported the view of Sir Charles Bell that the use of the orbicularis palpebrarum was to compress the eyeball and protect its delicate structures whenever the chest is violently contracted (vide Fig 4). He, moreover, points out that when infants scream loudly from hunger or pain the circulation is affected, and the eyes tend to become gorged with blood; consequently the muscles surrounding the eyes are strongly contracted as a protective; this action in the course of many generations has become firmly fixed and inherited, but when with advancing years and culture the habit is partially repressed, the muscles around the eyes still tend to contract whenever some slight distress is felt; although under the control of the will, a certain amount of escape of nerve energy along the path of associated habit cannot be avoided. "There is no art to find the mind's complexion in the face" is well illustrated by the action of the depressor anguli oris; its action, signalized in popular language as "down in the mouth," is indicative of mental depression or suppressed grief; in the child, just before it is going to burst out crying, or when it is trying to suppress a fit of crying coming on, the drawing down of the mouth by this muscle is especially noticeable. The wrinkling of the forehead and drawing down of the mouth, when constantly present, indicate prolonged sorrow and suppressed grief. They may be looked upon as an involuntary,

partial, but continuous leakage of nerve energy along preorganized paths of associated action expressive of a long-continued frame of mind, and therefore rudimental vestiges of the screaming fits expressive of bodily distress in early infancy.

Darwin points out that the pyramidalis of the nose are less under the control of the will than the others, and their contraction can only be checked by that of the central fasciae of the frontal muscle; these latter fasciae draw up the inner ends of the eyebrows and wrinkle the forehead in a peculiar manner, which we instantly recognize as the expression of grief or anxiety (vide Fig. 5).

We thus see that there is a great deal of truth in Sir Charles Bell's statement:

The organ of breathing in association with the heart is the instrument of expression, and is the part of the frame by the action of which the emotions are developed and made visible to us.

Again:

That what the eye, the ear, and the hand is to the mind in exciting those ideas which have been appointed to correspond

with the qualities of the material world, the organs of the breast are to the development of our affections.

Henle on the natural history of the sigh in his *Anthropologische Vorträge* calls attention to the fact that there is a contest between the striped skeletal muscles of respiration and the unstriped muscles of the lungs which seek to narrow the bronchial tubes. "In the normal state the former easily conquer but under other conditions they either conquer with difficulty or are defeated" (James).

The contrasted emotions express themselves in similarly contrasted-wise, by spasm and paralysis of the unstriped muscles and for the most part alike in all the organs which are provided with them as arteries, skin and bronchial tubes. The contrast

Fig 6.—A diagram to show the various functional groups of neurones in an upper thoracic spinal segment. The most anterior group is somatic; the group in the lateral horn is respiratory somatic; the group of small cells at the junction of the anterior and posterior horns (intermedio lateral) is viscerovascular. There are thus three groups of efferent neurones. There are two groups represented here of sensory neurones, efferent visceral and afferent somatic; they arborize around cells in the posterior horn. This diagram should be associated with the diagrams represented in Figs. 7 and 8. It will be observed that although the arrangement of the columns of cells is much more complex in the bulb, the same segmental functional groups exist. —, Respiratory. —, Visceral and vascular. —, Afferent visceral. —, Afferent somatic. —, Somatic. s, Skin. H, Heart. sc, Spinal cord. M, Muscle.

among the emotions is generally expressed by dividing them into exciting and depressing ones. It is a remarkable fact that the depressing emotions like fear, horror, and disgust, increase the contraction of these smooth muscles, whilst the exciting emotions like joy and anger make them relax. If there are pulmonary vasomotor fibres then these are constricted with the bronchial tubes, and a feeling of insufficient breath and oppression occurs, and the ineffective action of the diaphragm obtrudes itself upon consciousness by the fact that the external voluntary chest muscles have to be called to its aid to draw a deeper breath, and this is the sigh which we know is associated with anxiety and states of mental depression. It is quite possible that impulses from the higher centres in the brain may inhibit the inspiratory centre, and bring about the same effect as is produced by stimulation of the superior laryngeal nerve, causing thus an unpleasant sensation of resistance to the movements of inspiration which is relieved by a sigh.

I have already in my first lecture referred to fear and the physical phenomena associated with that emotional

state. Let us consider the opposite condition—anger—and see how far our knowledge of the functions of the systems referred to in the diagram (Fig. 6) serve to explain the phenomena of fear and anger. Darwin says Shakespeare sums up the chief characteristics of rage as follows:

In peace there's nothing so becomes a man
As modest stillness and humility;
But when the blast of war blows in our ears
Then imitate the action of the tiger.
Stiffen the sinews, summon up the blood,
Then lend the eye a terrible aspect;
Now set the teeth, and stretch the nostrils wide,
Hold hard the breath, and bend up every spirit
To his full height! On, on, you noblest English.
Henry V., Act III, Scene 1.

Bell points out that the muscles of the arms in man and the forelegs in ferocious brutes (the tiger) before they spring must have a fixed *point d'appui*, consequently the chest walls must be fixed, and to give the forelimbs their fullest power it must be raised and expanded as well as fixed.

Summon up the blood; this can only be done by inhibition of vaso-constrictor influence on the skin and muscles.

Fig. 7.—This diagram should be associated with Figs. 6 and 8. The important nuclei of the cranial nerves are functionally grouped as in a spinal thoracic segment. It will be observed that the sensory fifth is represented as spreading out like a fan to terminate in a column of cells continuous with the posterior horn; the three motor groups, as pointed out by Kappers, do not retain the definite alignment found in the thoracic spinal cord.

Set the teeth hard and stretch the nostrils wide: lend the eye a terrible aspect, will be effected by an increase of innervation currents to all the muscles supplied by the facial and motor fifth. *Hold hard the breath* is effected by a discharge of innervation currents to all the muscles supplied by the inspiratory column of cells. *Stiffen the sinews* necessitates a discharge from the whole motor somatic column of cells. In all these expressive actions of rage we do imitate the tiger before it springs. Can we explain the nervous mechanism which leads to this instinctive action showing antagonism between the action of the striped and unstriped muscle? In the dorsal region of the spinal cord where the original segmental arrangement is preserved we find somatic, respiratory, and viscero-vascular nuclei represented. In the normal and quiescent non-emotional state an equable reflex tonus by afferent stimuli is maintained in somatic, respiratory, and viscero-vascular muscle, but under the influence of the emotion (rage) there is a surcharge of nerve potential flowing out through the somatic and respiratory systems of neurones, consequently there may be a drainage away of the normal flow of potential by the viscero-vascular neurone; and a vascular dilatation will

occur; or the vascular dilatation may be explained by antidromic discharge along the posterior roots, which may, as Bayliss's experiments prove, lead to vaso-dilatation. But how are we conscious of this change in our bodily state? By the afferent impressions to the brain from the skin, muscles, and viscera, but mainly the two former, and these impressions will arise in the whole column of sensory cells, somatic and visceral, from the top of the fifth nucleus to the end of the spinal cord (see Figs. 6, 7, and 8).

Before reaching the seat of consciousness, however, these impressions will all be projected into the thalamic grey matter, where a fresh relay of neurones occur. But the thalamic region is also a station for receiving impressions from the special senses—hearing, sight, touch, taste, and smell—where relay neurones occur by which the several special sense stimuli are conveyed to definite regions of the perceptive cerebral cortex. The *thalamus* thus may be the great subconscious centre for the elaboration and co-ordination of sensory impressions derived from organic changes in the body and those brought by

Fig. 8.—This rough diagram was made during the lecture. It shows the relative positions of the five systems of neurones from the top of the medulla to the end of the thoracic spinal cord. The large swelling of the somatic motor group and the gap in the respiratory, the viscero-vascular motor, and the viscero-vascular sensory columns corresponds to the innervation of the upper limb, which is entirely connected with the life of relation and in association with vision plays a predominant part. In order that the diagram should not occupy too much space, the twelve spinal thoracic segments have been much curtailed relatively to the remainder.

the special senses from the material world around. The thalamus is connected with the corpus striatum, and it is possible that both the basal ganglia may be primary centres of emotional discharge to the lower centres.

Every thought tends to activation, and thoughts based upon the revival of memories of past experiences are more or less suffused with affective tone, according to the nature of the experience and the temperament of the individual. There will thus be a tendency to revival of the physical concomitants (emotions) of that affective tone. It does not require a delicate instrument to prove the truth of this statement in many instances, for we know that the recollection (revival in consciousness) of a great sorrow or injustice will awake sometimes a more violent emotional discharge than actually occurred at the time it was experienced. The experiments of Féché, Tarchanoff, Veraguth, and Jung and Petersen tend to support this conclusion; these observers have shown that if the body of an individual is

introduced into the circuit of a galvanometer through which a weak current is passing, and the resistance, being so arranged by means of a rheostat as to enable them to bring the needle to zero on the scale, psychical conditions will lead to a deflection of the needle of the galvanometer. The inference is that the psychical change produces some physical change by which the current passes less readily or more readily through the body. The results previously obtained by Féré and Tarchanoff have been corroborated and further elaborated by Veraguth, who found that if an individual introduced into the circuit be read to, deviation of the mirror is noted when passages associated with emotional tone are reached. Or if a series of unrelated words is pronounced by him, the words connected with some emotional complex produce an effect on the galvanometer, while indifferent words have no effect. He is unable to explain the changes in resistance. Jung and Petersen, who have repeated and elaborated the above experiments and applied the method of investigation to cases of dementia praecox, conclude that the change in resistance is due to the relative condition of secretory activity in the sweat glands.

A perception or an idea arises; it may suddenly, and before it can be controlled by the higher centres, lead to a diffuse emotional discharge—that is, a stimulus irradiates downwards into lower centres before it can be controlled. But when a person is of a stable temperament and has habitually practised control, the tendency of the perception or idea is to irradiate into the higher association centres, resulting in deliberation, judgement, and inhibition of the emotions. Perhaps the tendency at the present time is to suppress the affective side of our nature too much. "It should be the aim of mental culture to retain the emotions within the sphere of intellectual life, and so to get the benefit in the supply of the interest and energy required for effective volition" (Maudsley).

I fear in these two lectures I have left unsaid many things which I ought to have said, and said some things which I ought not to have said, but if I have stimulated your interest in a subject which is of profound importance in the study of nervous diseases, I am satisfied. You will find in practice, as Maudsley says, a "disordered emotion may act upon the animal life, the organic life, and the intellectual life." "It may grave itself in the lineaments of the countenance, or declare itself in the habit of the body; it may initiate or aggravate organic disease, producing, according to its duration, a transient or lasting derangement, and it may temporarily obscure or permanently vitiate the intelligence."

I hope at some future time to give at Charing Cross Hospital four lectures on the application of the physiology of the emotions to morbid states.

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 Jung and Petersen, *Brain*, vol. ii, 1907.

On March 19th the Maryland State Senate passed a Bill prohibiting Christian Scientists or faith-healers from practising in Maryland without the diploma of regular physicians. The Bill has already passed the House.

The American Therapeutic Society will hold its ninth annual meeting at Philadelphia on May 7th, 8th, and 9th. Among the features of the meeting is a "symposium" on diseases of the vascular system. Among the subjects to be discussed are: The pharmacology of heart stimulants, by Dr. Horatio C. Wood, jun. (Philadelphia); venesection in diseases of the heart, by Dr. Judson Daland (Philadelphia); and some conditions requiring caution in the use of digitalis, by Dr. Alexander D. Blackader (Montreal). Another feature will be a "symposium" on the treatment of tuberculosis.

THE CLINICAL VALUE OF THE PANCREATIC REACTION IN THE URINE, BASED ON OVER 250 ANALYSES.

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IN recent years the clinical researches of Mayo Robson and other observers have directed attention to the comparative frequency of serious organic disease of the pancreas and to the various clinical tests which assist in its recognition. More particularly, attention has been directed to the value of the pancreatic reaction in the urine, a test devised by Cammidge, which has proved in Mayo Robson's experience of great value in diagnosis. This test, first described by Cammidge in 1904, has been elaborated and improved, and in 1908 is again advanced by its originator as a valuable diagnostic method, after an experience of 800 analyses.

My interest in this subject was aroused in the course of the autumn of last year through the admission to Sir Thomas Fraser's wards, then under my care, of a case of chronic pancreatitis, in which this diagnosis had previously been established by operation. The object of the present paper is to present a brief summary of results I have obtained in a series of over 250 analyses from 120 consecutive cases. The test employed was the "improved method" as described in Mayo Robson's and Cammidge's recently published work on *Diseases of the Pancreas*. I have empirically divided the positive results obtained into three groups:

(a) *Pronounced*.—Those in which the end reaction showed a pronounced deposit of the crystals of characteristic appearance and solubility, the deposit ranging from about $\frac{1}{4}$ in. to $\frac{1}{2}$ in. in an ordinary test tube.

(b) *Marked*.—Those in which the deposit was much less in amount, but still considerable.

(c) *Slight*.—Those in which there was either a slight deposit on naked-eye examination or in which there was no naked-eye deposit, the presence of crystals only being determined on microscopic examination.

NOTE.—At the outset of my observations I experienced some difficulty with the test and failed to get any reaction. This failure may have been due to faulty chemicals employed. At a later date Dr. Cammidge kindly demonstrated to me the end reaction, and subsequently I have experienced no special difficulty with the test. The present series of analyses was carried out by a trained assistant in the laboratory of the Royal College of Physicians, the end reaction being determined by myself, a microscopic examination being made in every instance.

PRONOUNCED REACTION.

Clinical Diagnosis.	Remarks.
1. Chronic pancreatitis.	Pronounced reaction during acute attacks, on two occasions negative in interval.
2. Acute pancreatitis ..	Operation: Incision and drainage; cholecystenterostomy (Mr. Caird). Reaction gradually became less marked and was negative when patient was discharged cured.
3. Acute suppurative appendicitis and peritonitis	Died. Pancreas showed the naked eye and microscopic appearances of acute pancreatitis.
4. Malaria (aestivo-autumnal)	Jaundice with pronounced epigastric tenderness. Reaction became negative coincidentally with recovery from jaundice and epigastric tenderness.
5. Pneumonia	Died. Pronounced reaction three days before death; reaction negative on day of death. Pronounced arterial sclerosis. No post-mortem examination.
6. Chronic bronchitis, arterio-sclerosis, and myocarditis	Pronounced reaction on three occasions. Man, aged 48. Incapacitated from work.
7. Alimentary glycosuria and constipation	Marked diminution in the degree of reaction coincidentally with use of restricted diet and aperients.
8. Duodenal ulcer, chronic pancreatitis	Pronounced reaction associated with glycosuria. Extensive malignant disease was revealed at the operation.
9. Gall stones in common bile duct	Reaction negative on two occasions in December, 1907; slight positive reaction on day before operation (January 10th), reaction became very marked and patient died on fourteenth day. Pancreas showed the naked eye and microscopic appearances of recent inflammation.
10. Exploratory laparotomy	Palpable tumour in region of pancreas. Pronounced pancreatic reaction with trace of glycosuria; at the operation Professor Chiene found marked chronic pancreatitis.
11. Pregnancy, seventh month	Pronounced reaction associated with glycosuria (patient not seen by the author).