OBSERVATIONS ON VIBRATION SENSE WITH SPECIAL REFERENCE TO POSTENCEPHALITIC PARKINSONISM.

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IN this paper are recorded the results of quantitative measurement of vibration sense in a series of cases of post-encephalitic Parkinsonism. The method devised by Symms¹ was used for this measurement, a number of normal subjects being taken as controls. In view of the positive findings obtained, we attempted to detect minor quantitative abnormalities of proprioceptive sensation in Parkinsonism, but in this respect our results, to which we will refer, proved unsatisfactory. It was found that under standard conditions the length of time during which the vibrations of a tuning-fork could be felt was definitely reduced in all of 25 cases of generalised Parkinsonism that were investigated, although these showed no detectable abnormality of common sensation. The nature of vibration sense will be discussed and an attempt made to explain these findings in Parkinsonism.

By 'vibration sense' is meant the ability to appreciate the vibrations of a tuning-fork when the base of the latter is placed firmly upon a bony surface or prominence. The resulting sensation is commonly described by normal individuals in such a phrase as 'it feels like electricity.' A perusal of the literature reveals the existence of some difference of opinion regarding the exact nature of vibration sense, although most writers agree that it is a form of deep sensation. The classical research of Head and Holmes² on the sensory functions of the nervous system is the main source of present-day knowledge and theory concerning vibration sense. In their experiments, these investigators used a tuning-fork vibrating 128 times per second. Their conclusions may be summarised as follows: (1) Disease or injury at low levels in the nervous system frequently results in considerable impairment or complete loss of vibration sense. (2) So grave a loss never occurs in a stationary cortical lesion unless it is associated with epilepsy or other causes of shock. (3) They induce from their observations in health and disease that a large tuning-fork vibrating strongly is a stimulus to two aspects of sensation:—

(a) It produces a series of 'jarring contacts' which appeal to the activity of the thalamus. Vibration is appreciated in many cases where the essential organ of the thalamus has been freed from cortical control although the character of the sensation is entirely altered.

(b) The tuning-fork produces rapidly repeated movements of small range which can be recognised provided that the appreciation of passive movement is normal. This recognition, at least in its more delicate grades, is essentially cortical.

Clinically, there is an extremely close correlation between vibration sense and the ability to recognise passive movements, as when one is lost or impaired the other is affected to a proportionate degree. A normal response to vibration is produced by impulses passing up the deep afferent system. In the spinal cord the fibres carrying the impulses for vibration sense ascend in the posterior columns with those of passive movement and posture. Above the point where the mesial fillet ends in the thalamus no lesion produces complete insensibility to vibration except under conditions of neural shock.

Head attempts to explain the close relationship between vibration sense and the sense of movement and position as follows. In both instances, sensation is evoked by a succession of minute passive movements. Further than this, in order that passive movements may yield a sensation of movement, they have to be recognised as an orderly sequence tending in a certain direction. Passive movements not only lead to changes in place, but also to changes in time—introspectively, we appreciate changes in space and in time. In the same way, vibration must produce the impression of a series of minute contacts consecutive in time. Vibration is translated directly into its temporal aspect. It is possible introspectively to recognise that the tuning-fork produces rapidly repeated contacts, but its dominant effect is recognition of succession in time. From a developmental point of view vibration is closely associated with posture, e.g., the lateral line and the 'ear' of fishes are designed to assist in maintaining posture by responding to vibrations in the water. One may say that in vibration the attention is concentrated on the time aspect rather than on the minimal space changes.

Symns¹ maintained that the appreciation of vibration was a variety of pressure-sense—a summation of pressure-stimuli partly perceived by the skin but chiefly through the deeper tissues, especially bone. This view appears to us as less deserving of acceptance than that of Head and Holmes², which is founded upon extensive observation and experiment. The same objection applies to the unsupported suggestion by Tilney³ that vibration-sense is a special sense *sui generis* (which has been called 'pallæsthesia') and for which there exist particular receptor-organs in bone and periosteum responding only to vibrating stimuli. Symns, however, has performed valuable work in devising a method of quantitative measurement over a number of bony points sensitive to vibration. He applied a large tuning-fork, vibrating at a constant rate, to each of these bony points and measured accurately the time that elapsed before perception of the stimulus ceased. From a series of normal persons an average duration of perception for each bony point in health was obtained. Symns expressed his findings in the form of a graph which, together with his figures, is reproduced in figs. 1 and 2.

The following are the directions for obtaining the measurements. The tuning-fork is 13.5 inches in length, with blades 9 inches long and a vibration rate of 108.75 per sec. It is provided with a window-gauge attached to the adjacent free ends of the blades and consisting of two pieces of metal, one on each side, which tend to overlap. The overlapping margin of one of the pieces of metal is notched, allowing light to pass through when the blades of the fork are beating with wide excursions; as the vibration rate diminishes, the window gradually becomes smaller until such an excursion is reached that the notch is completely closed. At this point the handle of the fork is applied to a selected subcutaneous bony area and a stop-watch started. Meanwhile the patient has been instructed to indicate by raising a hand when he can no longer perceive the vibrations. In all cases the above procedure is repeated three times for each bony area and an average taken. It is found that in most cases the point at which perception of vibration ceases differs by no more than 1 or 2 seconds in the three tests. The times of perception when determined are plotted in graph form—the bony surfaces along the abscissa and the times along the ordinate. The following are Symms' average figures for normal individuals:—

	<i>Minimum Readings obtained.</i>	<i>Maximum Readings obtained.</i>	<i>Mean Readings.</i>
Internal malleolus	25 secs.	35 secs.	27 secs.
External malleolus	25 „	38 „	28 „
Tibia (external surface)	25 „	37 „	29 „
Anterior superior spine of ilium	16 „	25 „	21 „
Sacrum	15 „	23 „	20 „
Sternum	24 „	36 „	30 „
Radius (lower extremity)	28 „	40 „	33 „
Ulna „ „	28 „	42 „	34 „

We applied this method of measuring the perception of vibration to a series of 25 cases of generalised postencephalitic Parkinsonism of various degrees of severity. For the 25 cases, examining both sides of the body, the following mean readings were obtained:—

Internal malleolus	17 secs.
External malleolus	17 „
Tibia (external surface)	17 „
Anterior superior spine of ilium	16 „
Sacrum	11 „
Sternum	20 „
Radius (lower extremity)	22 „
Ulna „ „	21 „

The graph of these figures is reproduced and compared with that obtained from normal persons (fig. 1). It will be seen that the two curves are parallel but that of the Parkinsonian patients differs from the normal in showing a

diminution of the period of perception of the stimulus to one of 5—12 seconds less than the normal average. It was observed that the more severe the Parkinsonian syndrome the greater was the reduction in the period of perception. Thus in one severe case this period ranged between 11 and 20 seconds below normal (fig. 2). The evidence that we obtained suggested that the period of perception was lowest in cases with marked bradyphrenia. In patients whose physical states were approximately of the same degree of severity the one who showed the more bradyphrenia gave the lowest readings. Cases of Parkinsonism in which one side of the body was more involved than the other severally yielded lower readings on the more affected side.

FIG. 1.

A shortening of the period of appreciation of vibratory stimuli may be found, as would be expected, in any disease or injury of the nervous system peripheral or central, that involves the afferent proprioceptive fibres in any part of their course between the receptor organs in bones, muscles and joints, etc., and the sensory cortex in the parietal lobe. No condition has been described in which this period is lengthened. Postencephalitic Parkinsonism has always been described, typically and when uncomplicated, as being unassociated with sensory changes. This statement might have been due to the examinations for sensory changes being of the usual comparatively crude and gross type. Any sensory changes in Parkinsonism must be of a fine and

delicate nature, detectable only by similarly fine and delicate methods. The abnormality of vibration sense has these characteristics. To render our investigation of sensory changes more complete, we tested the sensibility of our patients to superficial pain (pin-prick) and to deep-pressure pain by means of Head's algometer and algometer. Our results with the algometer were very variable and untrustworthy, but with the algometer we found that the ability to appreciate deep-pressure pain was definitely reduced on the affected side in six cases of hemi-Parkinsonism. The instrument was applied to a number of selected points on both sides of the patient's body and increasing pressure applied until the appearance of pain was signified. The pressure was

FIG. 2.

then read off in pounds. The points selected were the palm and dorsum of the hand and the sole and dorsum of the foot. From 1 to 4 pounds more pressure on the Parkinsonian side than on the normal side was required to produce the same degree of pain, judged subjectively by the patient. A mean of vertical readings was taken.

How is the slight diminution of vibration sense and of appreciation of deep-pressure pain to be explained? In uncomplicated Parkinsonism there is no definite clinical evidence that the functions of the cerebral cortex are in any way affected. The main incidence of the infection is upon the substantia nigra in the crus cerebri, extension, however, commonly taking place in varying

degrees to the mid-brain, pons, and medulla below, to the level of the basal ganglia and thalamus above. It may be regarded as almost certain that the diminution of proprioceptive sensibility in Parkinsonism, as described, is due to the involvement of one of these areas. In cases of the thalamic syndrome produced by gross lesions, e.g., hæmorrhage, thrombosis, or neoplasm, which completely destroy the afferent fibres from thalamus to cortex, vibration sense and deep-pressure pain are not abolished. Their epicritic qualities alone are reduced and their protopathic increased. The protopathic appreciation of vibratory and pressure-pain stimuli takes place in the thalamus. In the case of a disease where the neuron damage is at the base of the brain and where the cortex is spared, as in postencephalitic Parkinsonism, we suggest that the slight impairment found in such aspects of proprioceptive sensation that could accurately be tested is due to some degree of depression of essential thalamic function. This conclusion is supported by the observation that, just as there is no evidence of cortical involvement in uncomplicated Parkinsonism, so there is suggestive evidence (which has been dealt with elsewhere⁴) of involvement of thalamic function, e.g., the primary emotional depression—the ‘bradyphrenia.’ It is in cases where this symptom is most prominent that the more pronounced sensory changes are found.

We are greatly indebted to Dr. D. N. Hardcastle for carrying out observations on the earlier cases investigated.

SUMMARY AND CONCLUSIONS.

(1) Twenty-five cases of generalised postencephalitic Parkinsonism were all found to exhibit definite impairment of vibration sense and deep-pressure pain when investigated by delicate quantitative methods which are described.

(2) The nature of vibration-sense is discussed and the conclusion that the protopathic appreciation of this sense and of deep-pressure pain occurs in the thalamus is emphasized.

(3) Evidence is brought forward to show the probability that the abnormalities of proprioception in Parkinsonism are due to some degree of thalamic depression by encephalitic infection.

REFERENCES.

- ¹ SYMNS, J. L. M., *Lancet*, 1918, i.
- ² HEAD, HENRY, *Studies in Neurology*, 1900, p. 568.
- ³ TILNEY, F., and RILEY, H. A., *Form and Functions of the Central Nervous System*, 1928, p. 8.
- ⁴ HILL, T. R., *Jour. Neurol. and Psychopathol.*, 1928, ix, 1.