SENSATIONS FOLLOWING NERVE DIVISION.

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WITH FIVE FIGURES.

I.—THE PRESSURE-LIKE SENSATIONS.

Since the confirmation and elaboration by Goldscheider, by von Frey and by others, of the discovery of Blix that there are points or areas on the skin sensitive only to certain forms of stimulation, physiologists have assumed a form of punctate sensibility in the skin. The work of these investigators has been taken to show that in the skin special nerves subserve the following sensations: heat, cold, pain and pressure (touch). On the other hand, the recent work of Head and his co-workers has not only cast considerable doubt on the validity of the broad generalization of punctate sensibility, but it is also plain that the earlier hypothesis is not in accord with the results obtained on man after injury or section of peripheral nerves.

Head, it will be remembered, investigated the sensibility to light touch, to different degrees of temperature, to pressure, to dual stimuli, to pain, to size and to movement in patients following injury or section of peripheral nerves and he carried his inquiries up to the point of recovery for all forms of sensation. The criticism of the older hypothesis, which was made possible because of these recent pathological studies, may well be summed up in the words of Head: "When the median nerve is divided, sensation is entirely lost over a considerable part of both index and middle fingers. Over the palm, within the area said by anatomists to be supplied by this nerve, sensation is usually diminished and not completely abolished.

In a similar manner, division of the ulnar nerve produces complete insensibility of the little finger, and of a variable part of the palm and the ulnar half of the ring finger. Such is the usual statement of surgeons and anatomists. . . . The most careful examination of the hand fails to show the slightest diminution in sensation over the median half of the palm in consequence of division of the ulnar nerve. What has always been called the diminished sensibility produced by the division of a nerve is really a condition in which some kinds of sensibility are lost and others retained.”¹

The results of careful examinations of about eighty patients, in whom the nerves of arm or leg had been divided or injured, led to the following conclusions: “The sensory mechanism in the peripheral nerves is found to consist of three systems:

“(A) *Deep sensibility*, capable of answering to pressure and to the movement of parts, and even capable of producing pain under the influence of excessive pressure, or when the joint is injured. The fibers subserving this form of sensation run mainly with the motor nerves, and are not destroyed by division of all the sensory nerves to the skin.

“(B) *Protopathic sensibility*, capable of responding to painful cutaneous stimuli, and to the extremes of heat and cold. This is the great reflex system, producing a rapid widely diffused response, unaccompanied by any definite appreciation of the locality of the spot stimulated.

“(C) *Epicritic sensibility*, by which we gain the power of cutaneous localization, of the discrimination of two points, and of the finer grades of temperature, called cool and warm.”²

The separate sensation elements in each of the three forms of sensibility may be tabulated as follows:

“Loss of *epicritic sensibility* abolishes: recognition of light touch over hairless parts or parts that have been shaved; cutaneous localization; discrimination of compass points; appreciation of difference in size, including the accurate discrimination of the head from the

¹Head, Rivers and Sherren: The Afferent Nervous System from a New Aspect. *Brain*, 1905, Vol. 28, p. 100.

²*Ibid.*, p. 111.

point of a pin apart from the pain of the prick (*acuesthesia*); discrimination of intermediate degrees of temperature, from about 25° C. to about 40° C.

"Loss of *protopathic sensibility* abolishes: cutaneous pain, especially that produced by pricking, burning, or freezing, together with that of stimulation with the painful interrupted current; over hair-clad parts, plucking the hairs ceases to be painful; sensations of heat from temperature above 45° C.; sensations of cold from temperatures below 20° C.

"After destruction of all cutaneous afferent fibers the part is still endowed with *deep sensibility*, pressure can be recognized, and its gradual increases appreciated; pain is produced by excessive pressure (measured by the algometer); movements of muscles can be recognized; the point of application of pressure can be localized; the patient can recognize the extent and direction of movement produced passively in all joints within the affected area."³

It will be seen, therefore, that the examination of patients in whom nerves have been injured or cut reveals many different degrees or qualities of sensation in addition to the four which, from the examination of normal individuals alone, have been supposed to be the only sensory elements. The main points of difference between the old and the new view—so far as the enumeration of sensations is concerned—are as follows: There is apparently a difference between the sensations of hot and warm, and between those of cold and cool; touch is different from pressure; there are different kinds of pain.

When, for example, the ulnar nerve has been cut, examination of the skin with various stimulating objects shows that over the hairless portions of the fourth and ring fingers light touches with a wisp of cotton wood or with a fine camel's-hair brush are not felt; the hair-clad parts may or may not react to such stimuli, depending upon the location of the lesion; parts of these fingers will not be sensitive to temperature stimuli, and perhaps not to pressure; there may, or may not, be sensations from pricks of a pin; and if the

³Head and Thompson: The Grouping of Afferent Impulses within the Spinal Cord. *Brain*, 1906, Vol. 29, p. 551.

fingers can not be moved voluntarily there will be a loss of sensibility to movement passively produced. Some of these effects may be found over a variable extent of the palm and the back of the hand. In Fig. 1 is given the condition found in a man following an operation in which part of the ulnar nerve was excised. The area insensitive to light touch and to the intermediate degrees of temperatures included all the little finger, about three-quarters of the ring finger, and about two-fifths of the palm and back of the hand. Part of

FIG. 1.—The extent of loss of sensation following the division of the ulnar nerve at the elbow. The part marked with horizontal lines was insensitive to light touches, and to intermediate degrees of temperatures. The vertical line area (cross-hatched on account of its being included within the area insensitive to touch), was, in addition, insensitive to pressures and to pain. Adapted from Head and Sherren.

this area was insensitive to deep touch and no sensation was got from the vibrations of a tuning fork. This area was also analgesic.

In this and other cases in which losses of sensibility were found, the ability to appreciate touch was tested with a wisp of cotton wool lightly brushed over the parts. When such a piece of cotton wool is carried over the skin of a normal individual, there is a distinct feeling of touch, which is magnified, perhaps altered, wherever the hairs are touched. The cotton wool should be very lightly grouped in a bundle, not tied, and I have found that on the hand a piece of cotton wool, weighing 55.5 mg., with a bending pressure of from 200 to 300 mg. will be accurately appreciated over the parts

which are not calloused.⁴ On the lips and parts of the face, a wisp of cotton wool weighing 20 mg. and bending at 200 to 250 mg., was just sufficient to produce a sensation. At times it is more convenient to use a camel's-hair brush, although Head has objected to the use of this instrument. I find it to be a more constant stimulus, in that it remains the same in bending strength for long periods. With cotton wool it is difficult, if not impossible, to select for each day's series of experiments an amount equal to that used on previous days, and if the same piece be used on successive days, it soon loses its original strength. In the experimental results that follow, I have used both cotton wool and a camel's-hair brush. I selected a long haired brush from which I cut off most of the outside hairs, leaving a brush 24 mm. long from the end of the hairs to the insertion, with about 125 hairs. As thus modified, the bending strength of the brush was 100 mg. for very slight bending, and about 200 mg. for more extensive bending. These figures are to be compared with the bending strength of the wisps of cotton wool mentioned above. I have found that the same results follow the use of the brush as the use of the cotton wool, and since, as mentioned above, it is more constant, it can be used for many patients as well as the same patient at different times.

For further tests I have employed the touch instrument of Bloch, which is illustrated in the accompanying figure. To a piece of wood was attached a spring steel wire A which was bent at a right angle B; the long part of this wire A measured six inches. The area of cross section was about 0.1 square mm. A scale E attached to the instrument enabled the experimenter to determine the pressure made by the wire in bending. The right-angled piece of wire was pressed against the subject's skin, care being taken to keep it vertical all the time, and when the patient reported that the pressure was perceived, the reading was taken from the scale and recorded. Two instruments of this character were constructed, one of which was

⁴Head and Sherren do not give any figures regarding these matters. In some later work, Head used a series of von Frey hairs with bending pressures of 830, 360, 230 and 100 mg., respectively. The use of these, however, more nearly approaches the use of the esthesiometer which will be described later.

approximately twice as strong as the other, in reality one division on instrument A equaled 0.6 division on instrument B. The instrument A enabled me to stimulate with tensions from 0 to 2000 mg., while instrument B enabled me to stimulate with tensions from 0 to 4000 mg. Each instrument was divided into arbitrary divisions, circular degrees, and since I was dealing with relative differences I did not translate the figures into terms of tension. All the figures that are included in the following tables are, however, directly comparable.⁵

FIG. 2.—Esthesiometer of Bloch. The figure is about one-third the size of the instrument.

The presence or absence of pressure sensations was determined by stimulating the parts with the pointed, but not sharp, end of a pencil. On normal parts this stimulus was immediately appreciated. Pain from pressure was determined by an algometer. The surface

⁵The value of such an instrument for determining differences in touch sensations was well brought out in some experiments, not yet published, on the touch thresholds in different parts of the body. One subject whom I examined carefully showed an increase in threshold values in the lower leg and foot on the left, although no similar difference was found to exist in other parts of the body. This leg was also smaller than the right, in circumference. When asked to explain the latter difference the subject replied that both knee and ankle of this leg had been injured at two different times and that for a period of six months six years previously she had this leg bound up and almost immovable. Another subject, a case of traumatic epilepsy, showed an increase in threshold values for touch on the right upper arm and shoulder, on the back over the scapula and over the chest above the breast, although otherwise both sides were the same. This was the only sensory or motor change that I found in this woman, and this persisted after the operation that was undertaken for her relief. In neither case did the testing with cotton show the least difference between the two corresponding segments of the body.

applied to the skin was circular, 3 mm. in diameter. This instrument was used instead of the usual algometer of Cattell, because it was necessary to make determinations on skin areas so close together that the large stimulating surface of the Cattell instrument would have been impracticable; and since the object of the work was to determine relative amounts of pressure causing pain, the smaller instrument was the more advisable.

The subject of the experiments is H., male nurse in the Government Hospital for the Insane, age 38, of good education, and interested not only in getting well, but also in the results of the experiments. For these reasons he was excellent in co-operation and the results were to be depended upon more than those from most patients, who may fear that the knowledge of their condition will be a hin-

FIG. 3.—Arm and hand of subject copied from photograph. Area insensitive to light touch marked with horizontal lines.

drance to their obtaining employment. His training in the examination of the insane was a benefit to him in noting his own condition, and his answers showed that his use of terms to describe his sensations was more accurate than that of similar untrained individuals, and the results are to be depended upon more than in those cases in which subjects have not been accustomed to note and to analyze mental symptoms. On June 20th, an inmate of the Hospital during a period of confusion attacked H. with a large pen knife and cut him in the left arm above the elbow, the wound extending 12 cm. from the dorsal side across the triceps muscle to the inner bend of the elbow. The lower part of the wound is to be seen in Fig. 3.

Immediately following the accident the patient was taken to the operating room. The triceps was found to be almost completely severed, and this was stitched together after the wound was thor-

oughly irrigated. No attempt at this time was made to discover nerve lesions. The wound healed by first intention. The day following the accident I saw the patient. So far as he could tell the thumb felt "dead" on the volar side, but there was no loss of sensation in the forefinger. The second, ring and little fingers also felt "dead". The area of anæsthesia to light touch, which was discovered at this time was over the ulnar part of the hand, back and front, and included the three fingers mentioned. I did not make careful notes of the condition at the time, and the accurate comparison of the anesthetic area at this time with what was found later can not be made. Following the accident the feeling in the thumb improved, but the sensation ability of the forefinger decreased. On August 12th, an exploratory operation was performed by Dr. G. T. Vaughan. The ulnar nerve was found divided near the olecranon; the median nerve was nicked, and there were excrescences or clubbed swellings on both edges of the nick. The ulnar nerve was brought together with sutures, the swellings on the median nerve were cut away and pieces of fascia were placed around the nerves to prevent the ingrowth of any scar tissue from neighboring parts. The results of my later examinations show that, in all probability, the medial antibrachial nerve was severed. This was not examined at the time of the operation. Immediately following the operation there was further improvement in the condition of the thumb, but the patient thinks this improvement was not marked. I did not examine the patient again until October 6th.

At the time of the first careful examination, I found the following condition: The little and ring fingers were totally anesthetic to all forms of stimuli, heat and cold, light touch and pressures. The middle and forefingers were anesthetic for all forms of stimuli over the two distal joints, both on the back and palmar parts. The palmar area corresponding to these two fingers was insensitive to light touch, but pressures could be appreciated and well localized. Pricks of a pin were painful. Up to this time there had appeared from time to time painful sensations following movements of the arm at the elbow, localized poorly, but apparently over the knuckles of the middle, ring and little fingers and over the palm at the place

where these fingers join the palm. Longitudinally the pains seemed to extend about three quarters of an inch, but, as said above, no very accurate localization can be made. In addition, heat (test tube with water heated to 45° C.) did not produce a sensation over the area insensitive to light touch and over half of the palmar part of

FIG. 4.—Hand showing areas insensitive to pressure, to light touch and to temperatures.

the thumb. Cold was not appreciated over the same area, although the test tube was cooled to 0° C., but there seemed to be a dissociation of the areas concerned with hot and cold sensations, for on the thumb, with the exception of the tip, no hot sensations were evoked, although cold was properly appreciated over the thumb with the exception of the first joint. Fig. 4 illustrates this condition.

Movement sensations were tested as follows: The eyes of the patient were closed or turned away so that he did not see what was being done. The left wrist was moved in the four possible directions and he properly duplicated these movements with his right wrist. Similar experiments on flexion and extension were made with the thumb, forefinger and second finger and similar results obtained. When, however, the ring and little finger were moved the patient gave no indication of the movement of these parts. Moreover, when the thumb and fingers were moved together so as to make a fist, the patient moved only the thumb and the first and middle fingers of the right hand. It was evident, therefore, that the patient had no sensations of movement from the little and ring fingers. Voluntary movement of the fingers of the left hand were poorly executed. The thumb could be moved only slightly, and this principally in flexion. The forefinger and middle finger also could be slightly flexed, while the third and fourth fingers could not be moved to the slightest degrees. No voluntary power to flex or to extend the wrist could be found. During the next ten days at times poorly localized, rather radiating, pains were felt over the ring and little fingers and on the back and outer aspect of the hand. No pain was felt on pressure of the fingers, nor on movement of the individual fingers. Pain, but slight, was felt on passive extensor movements of the wrist, but none on adduction and abduction. Pain at elbow on extension. During this period the subject complained of tingling sensations extending from the hand to the elbow, at times this pain was so severe that it prevented sleep. The flexion at the wrist was about 45° , extension about 20° . Flexion at elbow almost to the limit, extension about 150° . Very slight voluntary flexion of the first, second, and third fingers, but none of the fourth finger. A week later movement of the first and second fingers and thumb were properly sensed, movements of ring finger were sensed as movements, but patient could not tell which finger was being moved. No sensations from movements of the fourth finger. Side to side movements of the middle finger were sensed, but in attempting to duplicate them on the right side they were always made in the opposite direction, although the similar movements of the first finger and thumb

were properly expressed with the corresponding members of the uninjured hand. These results indicate clearly, I believe, that the motor sensations from the little finger were entirely unappreciated, those of the thumb and forefinger were appreciated in a normal manner or degree, while there was a change in appreciation of the movement sensations from the middle and ring fingers. The fact that the movements of the ring finger were sensed as movements does not necessarily imply that movement could be appreciated. Such movement sensations may have been due to the movement of the skin covering other fingers and palm, which gave more normal sensations, or they may have been due to movement of tendons or other tissues in the palm or back of the hand. It appears probable to me, however, that some movement sensation persisted in this finger, or, rather, we should say that the nerves conveying the impulses for movement sensations had sufficiently regenerated to enable a sensation to be produced. The results with the middle finger, especially the sideways movements, are extremely suggestive of an improvement in this part of the hand.

During the days that experiments were carried out, many times the patient reported that light touches, touches with cotton wool or a brush, over hairy parts were different in character than those over other normal parts. The way this was always expressed was that the sensations were stronger, or clearer. From the reports of Head's work, one may understand that there is a rather sharply defined line of separation of the parts sensible to cotton wool from those insensible to the same sort of stimulation. That this is not always so, was shown in my experiments. The patient would often feel the stimulus, and then again miss it in certain places, while in neighboring regions the stimulus often failed, but occasionally did produce a sensation. That there is no sharp line dividing the 'epieritic' and 'protopathic' areas is shown also by the results of a different sort of stimulation. If, instead of cotton wool or the light brush, we use an instrument that will enable us to give different degrees of stimulation, we find the area insensitive to cotton wool does not give a sensation on stimulation, even with considerable amounts of stimulation. Neighboring areas in which there can be

no doubt of the presence of both epicritic and protopathic sensibilities do not show a normal amount of sensibility to this form of stimulation. There is a gradual decrease in the loss or in the dullness of sensibility from the area of epicritic loss, we may say from area of complete sensibility loss, to the area in which no sensory change, according to Head's methods, can be demonstrated. The accompanying figure illustrates the conditions found on the hand.

The area tested was carefully examined for hairs, and wherever hairs were found, the part was carefully shaved. The part of the area insensitive to cotton wool was mapped out and recorded on the

FIG. 5.—To illustrate the sensibility of the hand determined by Bloch's instrument, compared with the loss of pressure and light touch sensations.

hand with red ink. The sensibility to pressure and to forms of stimuli denoting the presence or absence of protopathic sensibility was also tested and the areas of loss were marked on the part. Points were then selected separate from each other by 1 cm. These were also marked with red ink so that the stimuli could be given at approximately the same spots each time. These points were then examined with the help of Bloch's instrument illustrated above. Five experiments were made on each point and on corresponding points on the right hand. Table I gives the results of this form of examination. The letters indicate the corresponding areas on the left (nerve cut) and right hands. The figures give the averages of

five determinations of the just perceptible determined by one of the Bloch instruments.

TABLE I.
TOUCH THRESHOLDS ON HAND. BLOCH INSTRUMENT.

Points.	Left hand.	Right hand.
A	...	6.0
B	...	8.6
C	62.*	6.6
D	29.8	10.6
E	27.8	14.8
F	13.4	7.4

*Approximate, since instrument reads only to 60.

The point A on the left hand was within the area in which pressure (pencil) was not felt. B was within the area in which pressures were felt, but no sensations accompanied stimulation of cotton wool or a camel's-hair brush. C, D, E, and F, were areas in which the epicritic sensibility was found intact. It will be noticed from the table that the amount of stimulus to produce a sensation at point C was twice the amount of that necessary on the other areas, D, E, and F, and that it was greatly in excess of that required on the normal hand. The points D, E, and F, supposedly normal, showed an increase in the threshold value—approximately double the normal. On the fingers similar results were found. On the parts in which pressure of the pencil was immediately perceived, but no sensibility to cotton wool, the limit of stimulation with the Bloch instrument was not felt, and in the areas in which epicritic sensibility was retained there was an abnormally great threshold value. Only in those parts where cotton wool could be felt was it possible to make any determination with the Bloch instrument, and when the results in these experiments were compared with the results of the right hand, the difference between the apparently normal area of this left hand with the known normal area of the right, are as strikingly marked as those in the table just given, and those in the table mentioned below. On apparently normal points of the thumb of the left hand, sixteen experiments with instrument A gave

a threshold average of 29, while a similar number of corresponding points of the right thumb gave an average of 8.7. On the ball and on the back of the third joint of the thumb eleven experiments on the left hand averaged 42.1, and on the right, 20.5.

On the upper part of the forearm, a section including the area in which different forms of sensibility were altered, was carefully crossmarked in centimeter square divisions. This section of the area was carefully shaved so that these experiments could be carried out. Each of the thirty-five squares was then carefully tested five times. The averages were calculated and the results of these examinations are given in Table II.

TABLE II.
TOUCH THRESHOLDS ON VOLAR SIDE OF FOREARM. BLOCH INSTRUMENT B.

Points.	A	B	C	D	E	F	G
Aver. threshold	19.9	25.5	34.9	54.1*	46.*	54.*	

*Approximate.

The results for the five horizontal centimeter squares are grouped in this table. Below G the arm did not respond to temperature stimuli, nor to the stimulation of the hairs. Areas A, B and C reacted to all forms of temperature stimuli with sensations of hotness, warmth, coolness and cold, while area D responded to only some of these. These areas also gave results to brushing and pulling the hairs, while plucking the hairs in areas E, F and G gave no sensations. A full account of the results on the hair and temperature sensations in these areas will be found in a subsequent article. It is sufficient for the present to know that areas E, F and G were clearly devoid of epicritic sensibility, when areas A, B and C were, in accordance with Head's methods of examination, clearly normal.

In G and F the stimulus was perceived only once, although the instrument was pressed to its highest point. Twice in area E stimuli were perceived, seven times in area D, and always in areas C, B and A, when the pressure of the tension of the instrument became sufficient. A comparison of these results with the results of a similar examination of the right arm show that the stimulus necessary to

cause a sensation in the area A is normal, while the threshold values in B and C are greater than normal. This gradual change from no sensation to a normal sensibility threshold is striking. The results show that there is no sharp line separating the areas of protopathic and epicritic sensibilities, and it appears that the changes in the nervous system are more widespread than has hitherto been supposed. On the hand and arm the line separating the area in which the epicritic sensibility was lost from that in which it was retained, is sharply defined by cotton wool or by camel's hair pressure, but in view of the more quantitative experiments with the touch instrument of Bloch this line must be considered a very rough approximation, for the experiments show that the sensibility disturbance extends much beyond this line. For the distance of two centimeters beyond the line of epicritic sensibility loss, normal sensibility threshold as measured by the esthesiometer was not found.

These results may be explained in a number of different ways. At first sight they appear to confirm the hypothesis which has been advanced to explain all the results of Head and Sherren, namely, that we are dealing with differences in threshold value when we speak of epicritic and protopathic sensibility. The results which have been obtained on the sensibility to temperature and the result on the sensibility of the hairs are not in accord with such a hypothesis. It appears to me more likely that the gradual approach from the area of deep sensibility loss to the perfectly normal area, especially the gradual lowering of the threshold along the area in which the epicritic sensibility is present, indicates that there is an overlapping of the nerves as the anatomists used to teach, and which Head assumes is disproven by his discovery of the various forms of deep, protopathic and epicritic sensibilities. According to the accounts and conclusions published by Head and his co-workers, it would appear that there is no overlapping of these nerves, but a critical analysis of the cases published by Head and Sherren shows that they always found such an overlapping. For example, if we consider carefully the diagrams published by Head of the distribution of the median, ulnar and superior radial nerves of the hand, we find on the palm, the ulnar nerve is supposed to innervate that part of the palm which is on

the ulnar side from a line drawn through the middle of the ring finger; the superior radial nerves presumably the radial side to a line drawn through the middle of the thumb; while the remainder of the palmar part of the hand is innervated by the median nerve. All of these areas must have, according to Head, deep, protopathic and epicritic sensibilities. But Head's work shows that we seldom find areas of these different forms of sensibility occupying the same position on the hand. For the median, for example, there may be a loss of deep sensibility in the first and second fingers; but the rest of the area which is assigned to the median retains its deep sensibility. The retention of this sensibility must be due to fibers in other nerves. So also we find there is an overlapping of the epicritic sensibility, and it seems to me the results on II, as well as the results obtained by Head, clearly show such an overlapping effect. On the arm, the areas A, B and C, Fig. 3, were supposed to retain all their epicritic sensibility, whereas it is evident that areas B and C are not nearly so sensitive as area A.

The tests for threshold of pain sensations brought out no new facts. The areas which were carefully examined for touch thresholds, and which gave the results recorded above, were examined, but, with perhaps a slight increase in threshold over the whole lower arm on the left, there was nothing distinct. The measurements made with the algometer described above showed that in the area near the elbow (rectangle in Fig. 3) for each horizontal centimeter above the line of loss of deep sensibility there was no difference. The averages of three experiments in each longitudinal area are as follows: 978, 905, 779, 820, 970, and 923 grams. Similarly on the hand there were no sufficiently noticeable differences between the threshold in area B (Fig. 5) from that in area F.

The pains on movement of fingers, wrist and elbow are of a different character from those produced by pressure, and they have been mentioned in an early part of the article. They were not located at the place where the movements occurred, but were always referred to the fingers or hand. It seems likely that these were due to pressure on the nerve trunks, but this is purely speculative and is supported by only a few observations as follows: At times

the patient reported pain sensations produced by drawing his shirt sleeve up above the elbow; when the arm was pressed, and especially when pressure was exerted along the course of the nerve trunks, the subject felt pains in the fingers and palm, of a radiating character and apparently widespread.

The results of this study may be summarized as follows: There is a widespread disturbance in touch sensations following injury to the peripheral nerves, not only in the loss of certain forms of sensation but also in the increase of threshold values in much larger areas of the body segment than those in which there is sensation loss. This decrease in sensibility is marked for touch sensations, but is also apparent for the sensations that arise from stimulating the hairs and for the temperature sensations. The hair and temperature sensations will be more fully discussed in a subsequent article. With the exception of the areas in which no pain from pressure was felt, the pain thresholds are not altered, at least not in the same way as those for touch.

NOTE:—The results of the careful examinations of Dr. H. Head's arm in which the radial nerve was cut for the purpose of testing the sensibility have just been received (Rivers and Head: *A Human Experiment in Nerve Division*. Brain, 1908, Vol. 31, pp. 323-450). Owing to the recent appearance of this work, a note of the main features of difference cannot be added to the present article, but will be included as part of the second article of the series.

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