EXPERIMENTAL RESEARCHES ON THE TEMPERATURE OF THE HEAD. I. ON SOME POINTS RELATING TO THE TEMPERATURE OF THE HEAD. II. EFFECT OF VOLUNTARY MUSCULAR CONTRACTIONS. III. INFLUENCE OF THE TEMPERATURE OF THE AIR

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649579808

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Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

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Trieste

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BY

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LONDON:

H. K. LEWIS, 136, GOWER STREET.

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Communicated to the "American Neurological Association," June, 1880.

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NORMAL TEMPERATURE

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THE HEAD.

In a recently published work the writer of this article has given an account of investigations made by him on the temperature of the head, extending almost uninterruptedly over a space of more than two years.* In these investigations the surface of the head was divided by measurement into a number of small spaces (eighty-eight on each side), which were examined separately and by comparison with each other. Both thermometers and thermo-electric apparatus were employed in the experiments, the chief reliance, however, being placed on thermo-electric apparatus, as in the use of thermometers—among other sources of error—the temperature of the superficial vessels of the integument influences the result, the pressure of the instrument not being sufficient to empty these vessels, which can readily be compressed by the firm application of suitably constructed thermo-piles. It was found in these experiments, among other results, that every one of the small divisions of the surface of the head might be hotter on the right side or on the left side in turn, and also that many of them showed at times equality of temperature of the two sides. In this absence of a constant superiority of temperature on one side, the writer's results were in opposition to those of M. Broca, Dr. Gray, and MM. Maragliano, and Seppilli, who came to the conclusion that the left side has uniformly the higher temperature.

* 'Experimental Researches on the Regional Temperature of the Head.' London 1879.

Now the idea long ago suggested itself to the writer that *the degree of absolute temperature* of the parts examined might have something to do with the presence on the right side at one time, and on the left side at another time, of superiority of temperature, or again, with the presence, at certain times, of equality of temperature. In fact, a considerable number of observations seemed to show that near the higher limit of range of absolute temperature equality and superiority of temperature of the left side prevailed, while superiority of temperature of the right side was the most frequent condition at a lower absolute temperature.

To understand the different circumstances under which the temperatures of two parts may vary, so as to leave each one in turn warmer than the other, let us imagine a condition of things such as the following:—Suppose that of the two parts compared, one, "a," is, in the first place warmer, and, in the second place, cooler than the other, "b." When, in the second instance, "b" surpasses "a" in temperature, one of five things may have occurred, namely:—First, "b" may have risen in temperature in a degree exceeding the difference between it and "a," the temperature of the latter remaining constant; second, "a" may have fallen below the level of "b," the temperature of the latter being unaffected; third, both parts may have risen in temperature, "b," however, rising in a sufficiently greater degree than "a" to attain a higher final level than the latter; fourth, both parts may have fallen in temperature, the fall of "a" being, however, sufficiently greater than that of "b," to leave the former at the lower final level; fifth, "a" may have fallen and "b" have risen in temperature, the fall and rise being sufficient to leave "b" at the higher final level.

If we regard the thermal values of "a" and "b" as represented in the first place, by the temperatures 35·1° C., and 35° C. respectively, the following will represent the changes specified:

1st Instance.		2nd Instance.		3rd Instance.	
"a"	"b"	"a"	"b"	"a"	"b"
35·1° C.	35° C.	35·1° C.	35·2° C.	34·9° C.	35° C.

4th Instance.		5th Instance.		6th Instance.	
"a"	"b"	"a"	"b"	"a"	"b"
35·2° C.	35·3° C.	34·8° C.	34·9° C.	34·95° C.	35·05° C.

In all these instances the initial difference of 0·1° C. between the two parts is preserved.

Suppose, now, that in a given number of observations "a" is found to be the warmer by 0·1° C. with an absolute temperature of 35·1° C., while in another set of observations "b" is found to be the warmer by 0·1° C. with an absolute temperature of 34·1° C. If these observations were sufficiently numerous the inference would be that "a" has usually the greater range of temperature of the two parts, rising higher and falling lower than "b." In rising and falling between the above extremes a point must be touched at which "a" and "b" have the same temperatures. This point may, of course, be nearer either one of the extremes or midway between them. Above the neutral point "a" would have the higher temperature, while below this point "b" would be the warmer. But between the two extremes the position of superior temperature may alter more than once, and thus more than one neutral point may occur.

The following arrangement of thermometric values would represent such a condition of things as that alluded to. The "plus" sign is placed opposite the higher of the two values compared, and "zero" opposite equal values or neutral points.

	"a"		"b"	
	+35·1° C.	. . .	35° C.	
0 . . .	34·75° C.	. . .	34·75° C.	. . . 0
	34·40° C.	. . .	34·50° C.+	
0 . . .	34·35° C.	. . .	34·35° C.	. . . 0
	+34·35° C.	. . .	34·25° C.	
0 . . .	34·20° C.	. . .	34·20° C.	. . . 0
	34·00° C.	. . .	34·10° C.+	

Here we have the higher temperature twice in favour of each part, with three neutral points.

But although the neutral point must necessarily be touched at each reversal of position of the higher temperature,

yet it by no means follows that the temperatures of the two parts remain equal sufficiently long to enable one to prove the existence of neutrality with the instruments ordinarily used. The duration of the condition of equality may be too brief to be noticeable except by means of delicate self-registering appliances. It must, moreover, be borne in mind that equality of temperature is, at best, a *relative* condition depending upon the delicacy of the means of investigation employed; thus—other things remaining the same—equality would naturally be found more frequently with instruments incapable of testing difference of temperature less than 0·1° C. than with those capable of testing differences of 0·05° C. Further, the neutral point may be touched and held sufficiently long for satisfactory verification without subsequent reversal of the position of higher temperature ensuing. Again, the writer has called attention, in the work already cited, to the curious absence of any definite connection between the frequency of occurrence of neutrality or of superiority of temperature on a side, in the comparison of two parts, and the average thermometric difference displayed by these two parts. Thus, two parts with a comparatively slight average difference of temperature, being thus, as it were, constantly on the verge of equality or of a change of position of higher temperature from one side to the other, may yet seldom show equality or a change of the position of higher temperature from one side to the other, while two other parts, with a much greater average difference of temperature, may more frequently show equality or a change in the position of superiority of temperature from one side to the other. For example, two parts, "a" and "b," with an average difference of temperature of 0·05° C., may show 80 per cent. of cases of higher temperature for "a," 19 per cent. of cases of higher temperature for "b," and 1 per cent. of cases of equality of temperature; while two parts, "c" and "d," with an average difference of temperature of 0·2° C., may show 50 per cent. of cases of higher temperature for "c," 38 per cent. of cases of higher temperature for "d," and 12 per cent. of equality of temperature. These facts show that the variations of temperature with which we are concerned are, in a considerable

measure at least, not simply the result of steady and gradual rises and falls of temperature, differing slightly in degree in the two parts compared, due to regular alterations in the rate of calorific production alone, but that the furnaces, which we may suppose the parts to represent, are, in many cases at any rate, liable to sudden and decided interferences with their ordinary action, causing rapid and irregular exaltations and depressions of their powers, and this in each part independently of the other. Thus, it is evident that in the case of "c" and "d" given above, in order to furnish such relative percentages of those set forth, quick rises or falls of temperature of 0·2° C., at the least, must have occurred, every time equality ensued this difference having to be made up, and, of course, a still greatest deficit having to be supplied with each reversal of the position of higher temperature.

If the extreme limits of thermal range, beyond which no rise or fall can normally occur, be the same or nearly the same in the two parts compared, it follows, of course, that, in a united rise or fall of temperature in both parts, as these limits are approached the average degree of difference of temperature would naturally tend to diminish, until finally, when the bounds were reached, either equality would be present, or a minimum difference of temperature in favour of that particular part the extreme thermal limit of which had the highest absolute level. But even with the extreme limits nearly the same, and with a united rise or fall in the two parts towards a higher or lower general level, this rise or fall may be very unequal in the two parts at different periods, and thus not only may frequent shiftings of the position of higher temperature from one side to the other occur, but also all shades of difference of temperature may be found at different levels, according as the rate of rise or fall varies in the two parts independently of each other. Therefore, in the hypothetical case given on page 5, of a rise from 34° C. to 35·1° C., the uniform difference of temperature of 0·1° C., given for the sake of simplification, would not probably be maintained throughout; but although, as the general level rose the average difference might diminish, yet even almost to the extreme upper limit—supposing the rise