

**SPECIFIC GRAVITY OF THE BRAIN.** By R. H. C. GOMPERTZ, B.Sc., *Assistant Demonstrator of Physiology, King's College, London.*

(*From the Physiological Laboratory, King's College, London.*)

THERE are considerable variations in the statements which have been made concerning the specific gravity of the brain (Bischoff<sup>1</sup>, Danilewsky<sup>2</sup>). The most complete research on the subject appears to have been that of Danilewsky, who examined various regions of the central nervous system. He attempted among other things to determine the area of the whole cortex by a comparison of the weight of the brain, its specific gravity (1038), the specific gravity of the grey matter (1033), and white matter (1041), and the average thickness of the grey matter (2.5 mm.) De Regibus made similar calculations from the amount of water in the whole brain and in its two constituent substances<sup>3</sup>.

Among more recent writers, Halliburton<sup>4</sup> has determined the percentage of water in various parts of the nervous system; this is especially high in the grey matter, and in those regions where grey matter is abundant.

The present research was undertaken at Professor Halliburton's suggestion, as the matter had attracted his notice from an address on "Sex in Education" delivered by Sir James Crichton Browne<sup>5</sup> some years ago. Among the differences between the brains of men and women, Sir James stated he had found that the specific gravity of the female brain is less than that of the male brain; this difference was due to a difference of specific gravity in the grey matter, that of the white matter being the same in both sexes.

It was, however, pointed out in some correspondence that followed the publication of the address that this generalisation rested on very

<sup>1</sup> *Sitzungsberichte d. K. Bayer. Akad. d. Wiss.* II. p. 347. München, 1864.

<sup>2</sup> *Centralbl. f. d. med. Wiss.* XVIII. p. 241. 1880.

<sup>3</sup> See *Quain's Anatomy*, III. Part 1, p. 177. 1893.

<sup>4</sup> *This Journal*, xv. p. 90. 1894.

<sup>5</sup> *British Medical Journal*, I. p. 949. 1891.

few observations, the brains of two healthy men and one healthy woman having been investigated. Observations on the brains of lunatics, which were mainly used, can hardly be considered as likely to yield trustworthy results of what obtains in the normal state.

It was accordingly thought advisable to examine the brains in a larger number of cases. The experiments have been limited to the cerebral hemispheres of adult men and women who suffered from no brain disease. The cause of death and the age of each patient is stated in the following tables.

The brains were obtained as fresh as possible from the post-mortem room, and protected from evaporation until the observations were made.

As will be seen immediately there are considerable variations, which must in part be due to varying amounts of blood and lymph in the cerebral tissue. The only way to eliminate a changing factor is to obtain the average of a large number of observations.

The first observations I will describe are those in which I attempted to ascertain the specific gravity of white matter and grey matter separately; only instead of taking the brains of two men and one woman, I took those of two women and one man. The weighings were made in air, and in water, and the following are my results:

|                 | Cause of death  | Specific gravity of |                         |
|-----------------|-----------------|---------------------|-------------------------|
|                 |                 | White matter        | Grey matter             |
| Male, aged 35   | Typhoid         | 1·0381              | 1·0263 (Optic thalamus) |
| Female, aged 51 | Scirrhus        | 1·0392              | 1·0335 (Cortex)         |
| Female, aged 49 | Fractured spine | 1·0391              | 1·0329 (Optic thalamus) |

If these numbers were relied on, they would prove the exact contrary to what Sir James C. Browne stated to be the case. As a matter of fact they also showed me that there are considerable variations, and pointed to the necessity of making a larger number of observations in order to obtain an average.

These further observations were made in a rather different way. There is considerable difficulty in obtaining sufficient of the grey matter, especially from the cortex, so as to be quite certain that there is no white matter mixed with it. If one shaves off the grey matter a little too deep in parts, there will be a variable admixture with white matter which will vitiate the results. Accordingly it was thought better to take a large piece of the brain from several regions, and estimate the specific gravity of the whole pieces. These were cut as

nearly as possible from the same regions in each brain. Care was taken to completely and rapidly remove the membranes, to select pieces where there was no portion of the ventricles or other cavities where air might be imprisoned, to leave them in the water long enough to displace all entangled air, but not long enough to cause any solution of the brain substance. No correction was made in the weighings in air, for the small amount of air displaced. This, however, is a very small error, and may be regarded as practically constant; the results are, therefore, correct from a comparative point of view.

I will give my results in detail for the one case only.

Male, aged 40. Died of fracture of skull.

|                 |                      | Grammes |
|-----------------|----------------------|---------|
| Frontal pole.   | Weight in air ... .. | 59.1115 |
|                 | ,, ,, water ... ..   | 1.8270  |
|                 | Specific gravity ... | 1.0318. |
| Rolandic area.  | Weight in air ... .. | 41.2275 |
|                 | ,, ,, water ... ..   | 1.4155  |
|                 | Specific gravity ... | 1.0355. |
| Occipital pole. | Weight in air ... .. | 41.9805 |
|                 | ,, ,, water ... ..   | 1.4900  |
|                 | Specific gravity ... | 1.0368. |

It will be sufficient to give the other results with this one in tabular form.

*Specific gravities of male brains.*

| Age | Cause of death     | Frontal | Rolandic | Occipital | Whole brain |
|-----|--------------------|---------|----------|-----------|-------------|
| 50? | KCN poisoning      | 1.0348  | 1.0359   | 1.0390    | 1.0366      |
| 40  | Fractured skull    | 1.0318  | 1.0355   | 1.0368    | 1.0347      |
| 35  | Phthisis           | 1.0336  | 1.0349   | 1.0344    | 1.0343      |
| 24  | Typhoid            | 1.0366  | 1.0379   | 1.0385    | 1.0373      |
| 58  | Pneumonia          | 1.0351  | 1.0358   | 1.0326    | 1.0345      |
| 46  | Pneumonia          | 1.0366  | 1.0365   | 1.0364    | 1.0365      |
| 43  | Pulmonary embolism | 1.0381  | 1.0393   | 1.0387    | 1.0387      |
|     | Average sp. gr.    | 1.0352  | 1.0365   | 1.0366    | 1.0361      |

*Specific gravities of female brains.*

| Age | Cause of death  | Frontal | Rolandic | Occipital | Whole brain |
|-----|-----------------|---------|----------|-----------|-------------|
| 72  | Cancer          | 1.0368  | 1.0405   | 1.0382    | 1.0385      |
| 50  | Run over        | 1.0339  | 1.0351   | 1.0318    | 1.0336      |
| 51  | Scirrhus        | 1.0363  | 1.0333   | 1.0348    | 1.0343      |
| 24  | Stone           | 1.0368  | 1.0383   | 1.0405    | 1.0385      |
| 49  | Fractured spine | 1.0361  | 1.0371   | 1.0373    | 1.0368      |
|     | Average sp. gr. | 1.0360  | 1.0368   | 1.0365    | 1.0364      |

In addition to the twelve brains included in the foregoing tables I have only examined one other, namely from a man aged 55 who died of uræmia, and in whom the brain was markedly œdematous. The results obtained from this brain are:

|                |              |        |
|----------------|--------------|--------|
| Frontal pole   | sp. gr. .... | 1·0280 |
| Rolandic area  | „ .....      | 1·0350 |
| Occipital pole | „ .....      | 1·0307 |

This low specific gravity is obviously due to the œdema.

It will be noticed from the main results<sup>1</sup> shown in tabular form, that:

1. My numbers are somewhat lower than those given by Danilewsky<sup>2</sup>.

2. There are considerable variations between the specific gravities of different parts of the same brain, and of different brains in both sexes.

3. That the average specific gravity is practically identical in the two sexes, a small difference in the fourth place of decimals being negligible.

In conclusion, I may point out that a low specific gravity of the brain does not necessarily imply a poor quality, for the part of the brain which is most important and most active—the grey matter—has a lower specific gravity than the white matter<sup>3</sup>.

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<sup>1</sup> Since the above was written I have found in Poirier's *Traité d'Anatomie humaine* (Paris, 1899) a large number of observations on the specific gravity of the brain made by Peacock, Sankey, Bastian, Buckill, and others. The only one who touches the question of sex-difference is Peacock; he gives the average specific gravity of the male cerebrum as 1·034, and of the female cerebrum as 1·035. This difference which is in the same direction as the smaller difference I found is in Poirier's opinion too slight to be considered as definite, especially in view of the great individual variations.

<sup>2</sup> They accord very well with the numbers given in *Morris's Anatomy*, p. 726 (Ed. 1898); the source of the figures there quoted is, however, not given.

<sup>3</sup> A fallacy of this kind underlies many of the statements made on this subject in the discussion on the sex question. It is also seen in a communication made by J. P. H. Borleau (*Lancet*, II. p. 485, 1882), in which he draws attention, in the examination he made of the brain of a highly gifted man, not only to the great weight of the brain, but also to its *high* specific gravity.