Journal of Anatomy and Physiology.

ON THE RELATIONS BETWEEN THE WEIGHT OF THE BRAIN AND ITS PARTS, AND THE STATURE AND MASS OF THE BODY, IN MAN.

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I. THE RELATIONS BETWEEN THE WEIGHT OF THE BRAIN AND ITS PARTS, AND THE STATURE, IN MAN.

THE first part of this paper is devoted to a confirmation and extension of the conclusions recorded in a short communication already published in the *Proc. Roy. Soc.*, No. 163, 1875. The materials on which it is based, and the tables which it contains, are derived and constructed in part from the facts recorded by the late Dr Robert Boyd in the *Philosophical Transactions* for 1861, in part from his original MSS., and partly from fuller tables prepared by him to forward my purposes in regard to the present inquiry.

Whilst recently engaged in examining the brain of the late Mr George Grote, the historian of Greece, I endeavoured to obtain some definite information concerning the influence of variations in the stature on the weight of the brain and its several parts in Man. As is well known, the ratios of the weights of the encephalon or entire brain, of the cerebrum, and of the cerebellum, to the *weight* of the body, have been investigated by many observers, both past and present, including Sims, Clendinning, Tiedemann, Reid, Peacock, Boyd, Huschke, Wagner, Weisbach, and others of less note; but the great variation met with in the weight of the body, dependent on its different condition as to obesity or emaciation, at the moment of death, renders the numerical results thus obtained of little value as indications of the real relations which must exist between the development of the encephalon and its parts, and that of the body in fully grown and healthy persons of either sex. Tiedemann (*Das Hirn des Negers*, Heidelberg, 1837; *Phil. Trans.*, 1836, vol. cxxvi.), for example, than whom no one has examined

this question more thoroughly, found the proportionate weight of the brain to that of the body, in the adult, to range from 1 to 100 in very fat persons, and 1 to 27 in very lean ones; and it was only by the exclusion of extreme cases, and the selection of subjects of medium stoutness, that a mean ratio of about 1 to 40 (more nearly according to others, 1 to 36·5) was arrived at by him, for the average healthy adult, irrespective of sex and of exact age. Such and all similar results are entirely unsuited to form the groundwork for estimating the normal ratio of the weight of the encephalon to the actual mass of the body in individual cases; much less can the same method be trusted, as employed by Huschke and others, for the further attempt to determine the relative weights of the several parts of the encephalon, as compared with the body-mass.

The influence of *Stature* on the brain-weight in Man was first shown numerically by Parchappe (*Recherches sur l'encéphale*, &c., Paris, 1836), but his results are founded on a very small number of observations. The statements of other writers are of a general kind only. It is, of course, well established that the brain, taken as a whole, is absolutely heavier in men than in women, chiefly, as is admitted, on account of the greater stature and bulk of the stronger sex; and, herein, a certain influence of stature has necessarily been acknowledged. It has been further shown that, considering the two sexes apart, the brain is, as a rule, or on an average, absolutely heavier in tall than in short individuals; but the facts hitherto recorded, bearing upon this point, are very few. Again, the existence of a direct relation between the size of the brain, or rather between that of the cranium and the stature, has often been invoked in the explanation of the smaller cranial capacity of certain of the shorter and smaller races of mankind, such as, for example, the Hindoos, as compared with other Aryan races. Parchappe found that the variation in the absolute weight of the brain accompanying a difference in stature amounting to $3\frac{1}{2}$ inches was about 5 per cent. of its total weight, and that it was greater amongst men than women. But he based these two conclusions upon a comparison of only 9 tall persons, 5 males and 4 females, with 10 short ones, 5 males and 5 females. The mean height of the tall persons was 65·75 inches, that of the short persons, 62·25 inches; the mean weight of the brain in the former was 45·25 oz., and in the latter, 43·75 oz. (*op. cit.*, pp. 101–76).

As to the *relative* or *proportionate* amount of brain in comparison with the stature, in persons of different heights, neither Parchappe nor any other observer has endeavoured to estimate this point numerically, unless with reference to the difference of stature in the two sexes. Dr Thurnam (*On the Weight of the Brain*, &c., London, 1866, p. 15), indeed, states that Parchappe "inferred, that the weight of the brain in both sexes is relatively greater in tall persons than in short ones, &c.;" but this is not a correct interpretation of Parchappe's words, which are to the effect that in both sexes, the brain is sensibly heavier according to the stature, or "on account of the stature" ("en raison de la taille;" *op. cit.*, p. 76). In

fact, his meaning is that the brain is merely *absolutely* greater, not *relatively* greater, in tall than in short persons. Its relative proportions to the stature, in persons of different heights, are, in truth, not discussed by Parchappe at all, except in relation to the sexual differences. At the same time, if he had done this, his data, though so limited in number, would have shown him that the brain is relatively to the stature smaller in tall than in short persons of either sex, which, indeed, will be presently proved to be the case by reference to sufficiently ample data. It may here be noticed that M. Broca (*Mémoires d'Anthropologie*, t. i. p. 165, 1871), in discussing M. Parchappe's results, makes it appear that the percentage of cerebral difference between the tall and short males is identical with the percentage of their differences in height, stating that, both as regards the brain-weight and the stature, the increment in the tall males is exactly 6 per cent. over the quantities in the short ones. But the exact figures are 6·02 per cent. for the increase in the brain-weight, and 6·75 per cent. for that of the stature; so that, as just said, Parchappe's observations, though insufficient in number, really show that the brain is relatively to the stature somewhat smaller in tall persons. In the females, the respective figures are 2·02 per cent., and 5·92 per cent., thus establishing the same conclusion, but, as will hereafter be seen, in an exaggerated manner, owing doubtless to the paucity of the observations.

Weisbach, "Die Gewichtsverhaeltnisse der Gehirne," &c., *Archiv für Anthropologie*, Braunschweig, 1866–7, pp. 316–7. Weisbach has examined the influence of stature on the weight of the brain and its parts in a much larger number of cases than Parchappe, viz., in 429 subjects, the greater proportion of whom were males, being soldiers of various nationalities belonging to the Austrian Empire. But he has merely grouped his observations into three categories as to stature, without any record of individual measurements, and his conclusions as to the relation between the brain-weight and the height of the body are expressed in words and not numerically. With his most general conclusion, my own results are at variance; for, dividing his cases into those of large, middle-sized, and small persons—the latter being at least 5 feet (Vienna measure) high—he finds that the encephalon is *absolutely* heaviest in the middle-sized, and not in the largest-sized individuals, as is usually believed, and as I shall presently show to be the fact. As to the cerebrum and cerebellum separately considered, he does not compare them directly with the stature, so as to determine their proportionate weights in reference to the height, at different statures; but he compares each organ with the entire encephalon, in his three groups, and finds that, thus estimated, as the stature increases, the proportion of cerebrum to the whole brain diminishes, whilst that of the cerebellum increases—a conclusion which I can so far, but in a different manner, confirm.

In discussing the influence of Stature, as exhibited in a comparison of men with women, and as affecting the respective brain-

weights of the male and female, Parchappe (*op. cit.*, p. 70) instituted an ingenious mode of comparison between the sexes, for which Thurnam (*op. cit.*, pp. 15, 16) omits to give him credit, although he proceeds to employ it in calculations founded on the more extensive observations recorded in Dr Boyd's tables (*Phil. Trans.*, 1861). Parchappe pointed out that, whereas the ratio of stature between a given number of males and females was 1000 to 927, the ratio of their respective brain-weights was 1000 to 903. Hence, he concludes, in accordance with the statement of Aristotle, and in opposition to that of Meckel and others, that the brain in the female is smaller in proportion to her height than it is in the male in proportion to his. He moreover shows that, on adopting the estimated ratio of the weight of the body in the male to that of the female, given by Quetelet, viz., 1000 to 867, the curious result is arrived at, that, in reference to the weight of the body, as indeed Tiedemann found (*Phil. Trans.*, 1836, vol. cxxvi. p. 306), the female brain is heavier then the male brain. From the far more numerous data employed by Thurnam, the several ratios between the male and female proved to be as follows:—Of stature, 1000 to 932 ; of brain-weight, 1000 to 903 ; of body-weight, 1000 to 872—results which nearly concur with and confirm those of Parchappe.

It is obvious, however, that many of the above mentioned conclusions, whether expressed generally or numerically, exhibit, after all, the combined effects of at least two modifying conditions, viz., that of sex and that of stature, acting, it may be, in one or in opposite ways; so that, in order to eliminate sexual and other influences, and determine that of stature by itself, further inquiries are needed, in regard to the two sexes separately. Moreover, besides the effects of stature on the relative size of the entire brain, there remains to be considered its influence on the cerebrum and cerebellum respectively.

In investigating these points, I at first intended to have employed as one term in the requisite series of comparisons the estimated *normal weight of the body at its different heights* in each sex separately, and then to have taken the ratio of that normal weight to the mean ascertained weights of the encephalon and its several parts, at corresponding heights in the two sexes. In the well-known tables of M. Quetelet, and the less known tables of Dr Beddoe, materials for such determinations are to be met with. But, on trial, I found that a less circuitous and therefore, in the first instance, a preferable method—one, indeed, which was closer to the facts—was to take the *ascertained heights*, in the different *cases*, turn them into inches, and find how

much, expressed in *decimal parts of an ounce*, of *encephalon*, of *cerebrum*, of *cerebellum*, and of *pons with the medulla oblongata*, was associated with every *inch of height*. Being well aware of the fact that the *length of the trunk*, which is dependent chiefly on that of the vertebral column, is more uniform throughout a number of individuals than the *total height*, as measured from head to foot in the standing posture, which is largely influenced by the variable development of the lower limbs, I should have preferred to have employed the first-named standard of measurement. But, so far as I am aware, no observations of this kind have been made in conjunction with determinations of the weights of the encephalon and its parts in corresponding individuals, so that I was constrained to employ the total height.

In one of Dr Boyd's published tables (*Phil. Trans.*, 1861, vol. i. pp. 249–53) there is a record of the *average height* of 652 males of various ages, from twenty to eighty years and upwards, together with the *average weights* of the encephalon, the cerebrum, the cerebellum, and the pons with the medulla oblongata, at the corresponding periods of life. From this record I have constructed the following Table I., to which I have added the ratios of weight to height, calculated in the manner above mentioned, and also the ratio of the cerebrum to the cerebellum. The results are so regular as to create some confidence in this method of determining the relations between the weight of the brain and its several parts, and the stature of the body.

TABLE I.

Table showing in 652 adult *males*, at different decennial periods of life, from twenty years to eighty years and upwards, the *average* weight and height of the body; the average weights of the encephalon and its three chief subdivisions; the ratios of each of these to the stature, calculated in decimal parts of an ounce to every inch of height; and, lastly, the ratios of the cerebrum to the cerebellum, the latter being valued as 1. (The facts were collected by Dr Boyd in the St Marylebone Infirmary.)

Males.

No. of Cases.	Ages.	Average Weight in lbs.	Average Height in inches.	Average Weights in oz. Av.				Ratio of Weights in parts of an oz. to an inch of Height.				Ratio of Cerebrum to Cerebellum.
				Encephalon.	Cerebrum.	Cerebellum.	Pons and Medulla.	Encephalon.	Cerebrum.	Cerebellum.	Pons and Medulla.	
55	20–30	92·14	66·75	47·9	41·98	5·19	·93	·718	·629	·078	·014	8·09-1
103	30–40	93·35	66·5	48·2	42·07	5·15	·98	·725	·632	·077	·015	8·17
135	40–50	102	66·8	47·75	41·48	5·22	1·06	·715	·621	·078	·016	8
110	50–60	102·5	66	47·44	41	5·13	·98	·714	·621	·078	·015	8
123	60–70	103·13	65·7	46·16	40·21	4·98	·97	·701	·612	·075	·014	8·07
102	70–80	106·13	65·7	45·5	39·6	4·96	·94	·69	·602	·074	·014	8·1
24	80–90	99	66 7	45·34	39·62	4·79	·89	·68	·6	·073	·013	8·27
652	20–90	99·75	66·3	46·88	40·85	5·06	·97	·708	·619	·075	·014	8·07

The numbers of the cases examined, given in the first column of this table, show that these are sufficient to yield fair averages of heights and weights for comparison. Passing over the second column, which indicates the age of each group of cases, to the third, which contains the weights of the body, it is seen that these latter, even though reduced within certain bounds by the system of averages, exhibit no regular proportion to the heights of the body, or to the weights of the encephalon and of its parts; on the contrary, they remain far too irregular to be safely used as an element in the comparisons needed for the present inquiry.

The *average height*, in each group of cases, is, however, as shown in the fourth column, a far more uniform and regular factor, thus offering itself to notice as a safer basis of comparison.

The next four columns give the average weights of the encephalon, the cerebrum, the cerebellum, and the pons with the medulla oblongata, in the several decades of life, from twenty to eighty years and upwards. These figures show that the absolute weights of all these parts culminate, as a rule, in the decennial period extending from thirty to forty years, after which they decrease, at first slowly, and then more rapidly with advancing age. But besides these now acknowledged facts, the figures

indicate that these several parts diminish as life advances in different proportions. Thus, the actual decrease in the cerebrum, the cerebellum, and the pons with the medulla oblongata, between the ages of forty and eighty, is seen to be 2·47 oz., ·19 oz., and ·04 oz. respectively, so that at the age of eighty they have lost $\frac{1}{17}$th, $\frac{1}{27}$th, and $\frac{1}{24}$th of their respective weights at the age of forty. The cerebrum, accordingly, appears to suffer more loss from the effects of age than the cerebellum, not only undergoing a greater absolute diminution, but a greater amount of waste, proportionally to its own size, an important result, quite consistent with the presumed greater use of the former organ in relation to the mental processes.

The succeeding four columns contain the *ratios* between the *weights* of the encephalon and its three subdivisions, on the one hand, and the *stature* of the body on the other, expressed in decimal parts of an oz. av. to every inch of height, as this is recorded in the fourth column. These *stature-ratios* of the several organs, as they might be termed, display a very interesting progressive regularity at the different periods of adult life; but they also confirm, or show in another form, the declining weight of the encephalon and its parts as life advances, not only when considered in an absolute manner, but also, as just pointed out, when regarded in relation to the stature.

In the last column but one are set down the *ratios between the weights of the cerebrum and cerebellum*, at the several periods of life. These *cerebro-cerebellar* ratios display considerable irregularity, dependent on the condition, not sufficiently recognised, that they result from the comparison of *two* variable factors. The importance of this particular ratio, standing by itself has, indeed, been over-estimated; for it does not indicate whether a large or small proportion of cerebrum to cerebellum, in any given instance, is due to an individual peculiarity in the weight of one or other organ, or in that of both in opposite directions. To this point I shall possibly recur. Though not relevant to the present inquiry, a series of total averages of weights and ratios is given at the bottom of the several columns, not only for the sake of completeness, but on account of the interest which these possess, as will be seen when they are compared with the corresponding totals in the next table.

TABLE II.

Table showing the same facts as in Table I., but in relation to 715 adult *Females*. (Observed by Dr Boyd in the St Marylebone Infirmary; *op. cit.*, pp. 249–53.)

Females.

No. of Cases.	Ages.	Average Weight in lbs.	Average Height in inches.	Average Weights in oz. Av.				Ratio of Weights in parts of an oz. to an inch of Height.				Ratio of Cerebrum to Cerebellum.
				Encephalon.	Cerebrum.	Cerebellum.	Pons and Medulla.	Encephalon.	Cerebrum.	Cerebellum.	Pons and Medulla.	
70	20–30	86·13	62	43·7	38	4·82	·88	·705	·613	·077	·014	7·9–1
85	30–40	87	62	43·09	37·92	4·74	·91	·695	·611	·076	·015	8
97	40–50	84	62	42·81	37·12	4·69	·89	·690	·600	·075	·014	7·9
100	50–60	86	62	43·12	37·38	4·62	·86	·695	·603	·074	·014	8
142	60–70	86·14	61·5	42·69	37·13	4·68	·83	·693	·603	·076	·0135	7·9
146	70–80	80·4	61	41·27	35·58	4·47	·88	·674	·583	·073	·014	7·8
75	80–	79·5	60	39·77	34·47	4·47	·82	·663	·574	·074	·013	7·6
715	20–80	84·19	61·5	42·35	36·82	4·66	·87	·688	·599	·075	·014	7·85

This table illustrates the same general relations of the brain-weights to the age and the stature in females, as those already given in regard to males. The weights of the body are here also, as in the previous table, less regular than the heights. On consulting the totals at the bottom of the table, it will be seen that, on an average, the female encephalon is about 4½ oz. lighter than the male encephalon—the difference in the cerebrum of the two sexes accounting for 4 ozs. of that quantity, the rest being referable almost entirely to a difference of $\frac{4}{10}$ths of an oz. in the cerebellum. It will furthermore be observed, however, that these sexual differences are not to be wholly explained by the difference of stature in the two sexes; for the encephalon is shown to be not only absolutely smaller in the female, but to be so even *relatively to the height of the body*. Thus, the average proportion of entire brain in the female series is only ·688 oz. to every inch of height, instead of ·708 oz., as in the male series. It is, moreover, of importance to note that, as

thus tested, the relative preponderance of the encephalon to the body in the male, or its deficiency in the female, appears to exist entirely in the cerebrum, the average stature-ratio of that organ being ·619 oz. in the male, and ·599 oz. in the female series, whilst the average stature-ratios of the cerebellum, and of the pons with the medulla oblongata, are similar in the two sexes. The definite character of these results is of undoubted interest, and their confirmation would alone serve to prove the value of the mode of comparison, here adopted, between the weights of the encephalic organs and the stature in the two sexes.

On looking at the figures in the last column of this table, it will be seen that the ratio of the cerebrum to the cerebellum in the female series, exhibits as much irregularity at the different periods of life, as it did in the male series shown in Table I.

Nevertheless, on comparing the corresponding figures in the two tables, they indicate that, whilst with advancing age, the proportion of cerebrum to cerebellum increases in men, it, on the contrary, diminishes in women; moreover, the mean ratios, given at the bottom of the two columns, show that the proportion of cerebrum to cerebellum, taken at all ages, from twenty upwards, is greater in the male than in the female sex, being 8·07 to 1 in the former, and 7·85 to 1 in the latter. But, as already alluded to, these differences in the cerebro-cerebellar ratios in each sex at different ages, and in the two sexes at all ages, are so far illusory, as they may be due either to variations in one or other organ, or in both organs.

Now, a consideration of the stature-ratios of these organs under the different conditions of sex and age, as above recorded, at once throws light upon the questions at issue.

In the first place, the difference between the two sexes generally, as regards their cerebro-cerebellar ratios, appears to be due to a decided and real preponderance of cerebrum in the male, as compared with the female, in the proportion of about 62 to 60 (*i.e.*, as measured against the stature, of ·619 to ·599), and not to any marked difference either way in the cerebellum, which, as also measured against the stature, is of equal size (·075) in the two sexes. In the second place, as regards the opposite effects of age on the cerebro-cerebellar ratios in the

two sexes, it is shown by reference to the series of stature-ratios in the male and female series, at different periods of life, that the proportion of cerebrum to cerebellum is modified by a two-fold and contrary condition in each sex; for whilst, with age, the cerebrum diminishes less in reference to the stature in men than in women, viz., in about the proportion of 3 against 4 (*i.e.*, ·629 − ·600 = ·029 against ·613 − ·574 = ·039), the cerebellum diminishes more in men than in women, viz., in the proportion of 5 to 3 (*i.e.*, ·078 − ·073 = ·005 against ·077 − ·074 = ·003). This curious result coincides entirely with a conclusion arrived at by Weisbach on other grounds (*op. cit.*, p. 317), viz., on a comparison of the weights of the cerebrum and of the cerebellum with that of the entire encephalon, in a certain number of men and women at various ages; by which means he shows that, with age, in men, the proportion of cerebrum to the entire encephalon becomes greater, whilst that of the cerebellum becomes less; whereas, in women, with age, the proportion of cerebrum becomes less, and of cerebellum greater, in comparison with the entire encephalon.

It seems possible, moreover, that the unobserved influence of stature might serve to account for the conclusions arrived at by both Huschke (*Schaedel, Hirn und Seele des Menschen*, &c., Jena, 1854), and R. Wagner (*Vorstudien, &c., Abhandlungen der Koeniglichen Gesellschaft, &c., Goettingen*, 1861, p. 93), to the effect that if the *weight of the body* be taken as a standard of comparison, the cerebrum appears to be larger in women, and the rest of the encephalon larger in men, conclusions not easily admissible, and directly opposed to those of Weisbach and myself just stated. It is likewise not impossible that a reference to the effects of stature might explain, at least in part, a very remarkable and apparently incongruous contrast observed by Weisbach, as existing between the sexes, in the South German and Sclavonic brains which he examined, viz., that in the German women the proportion of cerebrum to the entire encephalon was larger, whereas that of the rest of the brain was smaller, than the corresponding proportions of those parts in the German men; whilst in the Sclavonic brains, the female cerebrum, as compared with the entire brain, was relatively smaller, and the rest of the brain (including the cerebellum,

pons, and medulla) was larger than in the male, in which sex the cerebrum was relatively to the entire brain larger, and the cerebellum smaller. In the Sclavonic women, the cerebrum was relatively smaller, and the cerebellum, pons, &c., were relatively larger than in the German women (*op. cit.*, p. 317).

Having thus examined the more general effects of stature on the encephalon and its parts, as detected by a comparison of *average* brain-weights with *average* heights, in the two sexes, the next step to be taken is to endeavour to determine its influence, if any, on the absolute and relative weights of the encephalon and its parts in *individuals*, or *groups of individuals*, of different known heights, in the two sexes separately. Now, in Dr Boyd's published tables, there are two series of maximum and minimum heights, and maximum and minimum weights of organs, in both sexes; but these merely constitute a register of the greatest and the least heights and weights met with in his entire research, and have no *individual* relation to one another. I accordingly appealed to Dr Boyd for permission to examine such of his original documents as might furnish the required data. From two sets of manuscript tables, which he at once placed at my disposal, containing the heights and the weights of the organs required, in 320 adult males and 325 adult females, all belonging to the insane class however, I constructed the two following tables.

TABLE III.

Table showing the average weights of the encephalon and its parts, and the ratios between those weights and the stature, together with the ratios of the cerebrum to the cerebellum, in 320 adult *male* lunatics, ranging between twenty and eighty years and upwards, and placed in five groups according to their heights. (From cases observed by Dr Boyd in the Somerset County Lunatic Asylum.)

Males.

No. of Cases.	Heights in Groups of 3 inches.	Average Weights in oz.				Ratios of Weight in parts of an oz. to each inch of Height.				Ratios of Cerebrum to Cerebellum.
		Encephalon.	Cerebrum.	Cerebellum.	Pons and Medulla.	Encephalon.	Cerebrum.	Cerebellum.	Pons and Medulla.	
67	70–72	48·18	41·6	5·47	1·11	·678	·586	·077	·015	7·6 to 1
122	67–69	47·83	41·5	5·24	1·09	·703	·610	·077	·016	7·9 „ 1
102	64–66	46·92	40·8	5·04	1·08	·722	·627	·0775	·016	8 „ 1
21	61–63	45·59	39·8	4·8	·99	·735	·643	·079	·016	8·1 „ 1
8	58–60	46·02	40·35	4·7	·97	·780	·682	·08	·0164	8·5 „ 1
320	70–60	46·91	40·81	5·05	1·05	·725	·630	·078	·015	8·02 „ 1

Neglecting the lowest group of cases, viz., that between 58 and 60 inches in height, as including so small a number of facts, it is shown that between the heights of 61 and 72 inches the absolute weight of the encephalon increases with the stature by 2·59 oz., *i.e.*, by $\frac{1}{17}$th of its own weight at the lower stature. Of this increase, the cerebrum takes 1·8 oz., the cerebellum ·67 oz., and the pons with the medulla ·12 oz., *i.e.*, quantities which are equal to $\frac{1}{22}$nd, $\frac{1}{7}$th, and $\frac{1}{8}$th of their respective weights at the lower stature. Considering the size of the two organs, the cerebellum in the *insane*, increases, therefore, in absolute weight more than the cerebrum, as the height of the body is increased.

Studying next, however, the columns containing the stature-ratios, or ratios of weights in ozs. to inches of height, it is plain that, in these cases also, the encephalon and its parts do not keep pace in growth, with the growth of the body; for, in each instance, the proportion to every inch of height becomes less as the stature itself increases. In the case of the encephalon the proportion varies from ·735 to ·678; in that of the cerebrum from ·643 to ·586; and in that of the cerebellum from ·079 to ·077 decimal parts of an oz. to every inch of height. Moreover, it is evident that this diminution of the ratio of brain substance to the body, which appears to occur in the taller insane individuals, is greater in the case of the cerebrum than in that of the cerebellum, amounting in the former to $\frac{1}{11}$th of the cerebral stature-ratio at the lower stature, and in the latter to only

about $\frac{1}{40}$th of the corresponding cerebellar stature-ratio. It is therefore apparent that, *relatively to the body*, the cerebellum changes less, or, in other words, follows the stature more closely than the cerebrum, which condition, however, we shall find is peculiar to the insane, and is connected with the waste of the cerebrum, and the preponderance of the cerebellum due to or accompanying the insanity. The unequal influence of stature on these two organs is also well illustrated by the progressive differences in the ratios of the cerebrum to the cerebellum, at different heights of the body; for, whereas, as shown in the final column, the ratio, in insane males between 58 and 60 inches in height, is 8·5 to 1, it changes step by step, until it becomes only 7·6 to 1, in persons measuring from 70 to 72 inches. In this case, the test of stature shows most conclusively that, in the insane, both organs diminish relatively to the body, as the stature increases, but the cerebrum more than the cerebellum.

It may here further be observed that, since, as already shown in Tables I. and II., the cerebrum diminishes more according to the age, and, as now indicated, increases less according to the stature, than the cerebellum, so the combined effect of both these influences in diminishing its stature-ratio is greater in tall than in short persons; and, conversely, as the cerebellum diminishes less by age, and increases more with the stature, so the joint effect of both these influences upon its stature-ratio will be more marked in short than in tall persons.

From all that has preceded, the cerebrum presents itself to us as a more independent organ than the cerebellum, in reference to the body generally; for it is less uniformly developed with, and in proportion to the stature, and it undergoes relatively greater waste from age; whilst, on the contrary, the cerebellum, in both respects, shares the fortunes of the body more closely.

So far as can be determined, the pons and medulla oblongata seem, as might be anticipated, to follow the condition of the cerebellum rather than that of the cerebrum.

TABLE IV.

Table showing the same particulars as Table III., but relating to 325 adult *female* lunatics, between twenty and eighty years

of age and upwards. (From cases observed by Dr Boyd in the Somerset County Lunatic Asylum.)

Females.

No. of Cases.	Heights in Groups of 3 inches.	Average Weights in oz. Av.				Ratios of Weights in parts of an oz. to an inch of Height.				Ratios of Cerebrum to Cerebellum.
		Encephalon.	Cerebrum.	Cerebellum.	Pons and Medulla.	Encephalon.	Cerebrum.	Cerebellum.	Pons and Medulla.	
8	67-68	42·53	36·62	4·9	1·01	·628	·542	·072	·014	7·5 to 1
113	64-66	41·88	36·27	4·63	·98	·644	·558	·071	·015	7·8 ,, 1
135	61-63	42·92	37·11	4·82	·99	·691	·598	·077	·016	7·7 ,, 1
65	58-60	41·36	35·97	4·47	·92	·700	·610	·075	·015	8·03 ,, 1
6	54-57	39·03	34	4·16	·87	·697	·607	·074	·015	8·17 ,, 1
325	54-68	41·54	36·0	4·59	·95	·672	·583	·074	·015	7·84 ,, 1

This table shows that in insane women, as in insane men, the encephalon increases absolutely in weight with an increase of stature; but the quantities indicated are not quite so regular as in the corresponding columns in Table III., relating to men.

It is also obvious that, taking a range of stature in both sexes of 10 or 11 inches, *i.e.*, from 58 to 68 inches in the females, and from 61 to 72 inches in the males, the absolute increase is much less in the women than in the men, the quantities being, as regards the entire encephalon, 1·17 oz. and 2·59 oz. respectively. In this comparison, of course, the males selected have an actually higher stature than the females selected; but, if we take an equal range at similar statures in the two sexes, viz., from 58 to 66 inches, the absolute increase in the encephalon in the females is ·52 oz. and in the males ·9 oz. As to the cerebrum and cerebellum, considered separately, the former organ shows a somewhat greater tendency than the latter to an absolute increase in the taller women, as compared with the increase in the taller men, being $\frac{1}{13}$th and $\frac{1}{5}$th of the absolute weights at the lowest stature, instead of $\frac{1}{22}$nd and $\frac{1}{7}$th.

Furthermore, the fact is apparent, from the stature-ratios in this table, that the weight of the encephalon and its parts diminishes, in the insane women as in the insane men, relatively

to the stature, as this last increases. The diminution of the female cerebrum in proportion to the stature, as observed between the heights of 58 and 68 inches, is measured by $\frac{1}{8}$th part of the stature-ratio at the lower height; whilst that of the cerebellum amounts to only $\frac{1}{24}$th part of its corresponding stature-ratio. This is for a difference of 10 inches of height, whereas for 11 inches difference in the male, the corresponding quantities were $\frac{1}{11}$th and $\frac{1}{40}$th part. Hence, stature had a greater influence in the women than in the men.

It is shown, moreover, by comparing the columns containing the ratios between the weights of the encephalon and its parts, and the stature, in this Table and in Table III., that not only the average stature-ratios given at the bottom of each Table, but the stature-ratios at identical heights of the body, in the two sexes, indicate a greater proportionate weight of brain-substance to every inch of height in the male, than in the female series. This evidently depends upon *sexual differences* in the encephalon and its parts overriding the influence of mere stature; which latter, by itself, ought to induce a lower ratio of brain-weights to the stature in the taller sex. The import of this will not be overlooked. It becomes still more interesting when we observe that this smaller proportion of brain-substance to the stature in the female sex, as compared with the male, chiefly concerns the cerebrum, only slightly the cerebellum, and almost imperceptibly the pons with the medulla, as may be seen on comparing the mean stature-ratios of each organ in the two sexes shown at the bottom of each column.

In conclusion, it is seen that the mean ratio of the cerebrum to the cerebellum is, likewise, smaller in the female than in the male encephalon, being as 7·84 to 1 instead of 8·02 to 1. It is only, as already observed, by referring to the test of the stature-ratio of both organs, that we can say positively that this is owing to a sexual diminution of the cerebrum, and not to a sexual enlargement of the cerebellum; indeed, at average or even identical heights, this latter organ is, relatively to the stature, itself somewhat smaller in women, so that to establish a lower cerebro-cerebellar ratio, the cerebrum must be relatively still smaller. In the female, as in the male series, the cerebro-cerebellar ratio diminishes as the stature increases, also owing

to the more marked diminution of the cerebrum, as compared with that of the cerebellum, in the taller women.

As Tables III. and IV. were compiled from observations made upon the insane, and irrespective of age, it seemed to be most desirable to collate, in a similar manner, but also with reference to age, the numerous facts collected by Dr Boyd amongst the *sane*, so that I again applied to him; whereupon, he promptly offered to reduce all the available data in his possession, relating to both the sane and the insane, into suitable tabular forms for the purposes of the present investigation. From the full tabulated results of his labours the following condensed tables have been derived.

TABLES V. and VI.

Tables showing the average weights of the encephalon and its parts, at seven decennial periods of adult life, from twenty years to eighty years and upwards, in 1150 *sane* persons, viz.,

Males.

Total No. of Cases.	Ages.	Stature 69 Inches and upwards.					Stature 68 to 66 Inches.					Stature 65 Inches and under.				
		No. of Cases.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	No. of Cases.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	No. of Cases.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.
52	20–30	14	48·1	42	5·1	1	23	49·1	42·8	5·3	1	15	46·1	40	5·2	·9
60		10	48·1	41·5	5·5	1·1	28	50	43·6	5·4	1	22	47	40·9	5·1	1
94	30–40	23	50·7	44·3	5·4	1	48	47·5	41·5	5	1	23	47·5	41·9	4·7	·9
100		29	48·9	42·2	5·6	1·1	41	47	40·8	5·2	1	30	45	38·9	5·1	1
116	40–50	28	48·5	42·4	5·2	·9	56	47·6	41·4	5·2	1	32	46·2	40·2	5·1	·9
70		30	47·3	40·7	5·5	1·1	31	45·5	39·1	5·4	1	9	43·1	37·1	4·9	1·1
103	50–60	24	47·2	41·9	5·2	1	47	46·8	40·8	5·1	·9	32	45·7	39·9	4·9	·9
60		23	48·5	42·1	5·3	1·1	27	46	39·8	5·2	1	10	46·8	40·7	5·1	1
118	60–70	31	47·9	42	4·9	1	57	46·8	40·8	5	1	36	45·4	39·6	4·9	·9
62		17	47·5	41	5·4	1·1	30	46·7	40·6	5·1	1	15	45·7	39·9	4·8	1
92	70–80	16	48	42·1	4·9	1	41	45·9	40	4·9	1	35	43·9	38·4	4·6	·9
34		6	48·5	42·1	5·4	1	22	46·5	40·5	5	1	6	44·8	38·5	5·2	1·1
23	80–90	5	43·4	38·3	4·4	·7	10	46·4	40·5	4·9	1	8	45·2	39·4	4·9	·9
14		4	44·9	39	4·8	1·1	4	43·4	37·4	5	1	6	44·5	38·7	4·7	1·1

598 *males* and 552 *females*, and in 725 *insane* persons, viz., 400 *males* and 325 *females*, being a total of 1875 persons, arranged vertically in three groups, according to certain selected heights, viz., the males, in groups measuring 69 inches and upwards, 68 to 66 inches, and 65 inches and under, and the females, in groups measuring 64 inches and upwards, 63 to 61 inches, and 60 inches and under. The tables also show the number of cases examined under each head. The figures relating to the sane are in upright Roman type, those relating to the insane in Old Style type. (Reduced from a table constructed by Dr Boyd from data observed in the St Marylebone Infirmary and the Somerset County Lunatic Asylum.)

Females.

Total No. of Cases.	Ages.	Stature 64 Inches and upwards.					Stature 63 to 61 Inches.					Stature 60 Inches and under.				
		No. of Cases.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	No. of Cases.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	No. of Cases.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.
62	20–30	18	44·4	38·9	4·7	·8	32	42·6	36·8	4·9	·9	12	41·5	35·9	4·7	·9
42		17	43·3	37·4	4·9	1	13	41·1	35·6	4·5	1	12	37·9	32·7	4·2	1
71	30–40	26	44·8	39·3	4·7	·8	30	43·4	37·7	4·8	·9	15	42·9	37·5	4·6	·8
36		14	42·7	37	4·7	1	16	42·7	36·7	5	1	6	44·9	38·9	5	1
81	40–50	32	42·5	37·1	4·6	·8	35	42·9	37·4	4·6	·9	14	43	37·4	4·7	·9
79		30	41·9	36·3	4·6	1	33	43·2	37·3	4·9	1	16	42·2	36·7	4·5	1
90	50–60	32	42·8	37·2	4·7	·9	35	42·8	37·3	4·6	·9	23	42·3	37	4·5	·8
59		21	44·8	38·9	4·9	1	22	41·9	36·3	4·7	·9	16	41·5	36·2	4·3	1
128	60–70	45	42·7	37·3	4·6	·8	52	42·6	37·2	4·5	·9	31	42·4	37	4·5	·9
71		29	42·5	36·8	4·7	1	26	43·5	37·7	4·8	1	16	42·5	36·7	4·8	1
56	70–80	26	41·3	35·9	4·6	·8	15	40·4	35	4·5	·9	15	40·7	35·6	4·3	·8
25		8	43·7	37·9	4·8	1	8	42·3	36·4	4·8	1·1	9	40·8	35·5	4·4	·9
64	80–90	18	40·9	35·6	4·4	·9	18	39·4	34	4·6	·8	28	39	33·7	4·4	·9
13		1	44·5	38·5	5	1	17	40·2	34·5	4·8	·9	5	38·5	33·2	4·3	1

These two rather copious tables contain much valuable information in a condensed form. They supply materials for certain comparisons between the insane and the sane; and in regard to the latter, they not only serve to confirm certain con-

clusions already arrived at, and stated in the preceding pages, but they furnish a series of approximately accurate weights, with which to compare the brain-weights of any given individual of either sex and of any age and height, and they also enable us to proceed to isolate the separate influences of sex, age, and stature on the weight of the encephalon and its parts, in a sufficient number of cases of sane persons to render the results reliable.

For these latter purposes, however, the tables may be still further condensed, by arranging their numerous data into three groups corresponding with the ages, instead of seven—viz., one containing the data relating to persons between twenty and forty years of age, when the brain has reached its prime; a second, those relating to persons between forty and seventy years of age, during which period the brain gradually declines in weight; and a third, those relating to persons beyond seventy years of age, in whom the brain has become actually senile. The following tables are the result.

TABLES VII. and VIII.

Tables showing, in the sane and the insane of both sexes, the average weights of the encephalon and its several parts,

Males.

Total No. of Cases.	Ages.	Stature 69 Inches and upwards.				Stature 68 to 66 Inches.				Stature 65 Inches and under.			
		Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.
146	20–40	49·72	43·43	5·29	1	47·99	41·9	5·09	1	46·95	41·15	4·9	·9
160		48·69	42·02	5·57	1·1	48·18	41·9	5·28	1	45·84	39·74	5·1	1
337	40–70	48·15	42·1	5·09	·96	47·08	41·01	5·1	·97	45·74	39·88	4·96	·9
192		47·74	41·23	5·41	1·1	46·03	39·8	5·23	1	45·32	39·39	4·91	1·02
115	70–90	46·92	41·19	4·8	·93	46	40·1	4·9	1	44·15	38·6	4·65	·9
48		47·06	40·86	5·16	1·04	46·02	40·02	5	1	42·98	36·93	4·95	1·1
598	20–90	48·40	42·34	5·09	·97	47·13	41·08	5·06	·99	45·61	39·84	4·87	·9
400		48	41·46	5·44	1·1	46·86	40·65	5·21	1	45·31	39·27	5·02	1·02

arranged in three horizontal divisions corresponding with certain periods of life, and three vertical divisions corresponding with certain differences of stature. The figures relating to sane are, as before, in Roman, and those relating to the insane in Old Style type. (Reduced from Tables V. and VI.)

Females.

Total No. of Cases.	Ages.	Stature 64 Inches and upwards.				Stature 63 to 61 Inches.				Stature 60 Inches and under.			
		Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.
133	20–40	44·64	39·14	4·7	·8	42·98	37·23	4·85	·9	42·26	36·78	4·64	·84
78		43·03	37·22	4·81	1	41·97	36·20	4·77	1	40·24	34·77	4·47	1
299	40–70	42·67	37·21	4·63	·83	42·75	37·29	4·56	·9	42·49	37·08	4·54	·87
209		42·87	37·16	4·71	1	42·94	37·16	4·81	·97	42·07	36·54	4·53	1
120	70–90	41·13	35·77	4·52	·84	39·84	34·45	4·55	·84	39·59	34·36	4·36	·87
38		43·78	37·96	4·82	1	41·31	35·51	4·8	1	40·04	34·75	4·36	·93
552	20–90	42·76	37·32	4·62	·82	42·37	36·84	4·64	·89	41·53	36·17	4·5	·86
325		42·98	37·24	4·74	1	42·54	36·74	4·8	·98	41·28	35·81	4·49	·98

The average weights in these tables have been obtained, not by simply combining those in the fuller tables, but by multiplying the weight, in each case, by the number of brains examined at that weight, adding the products thus obtained, and dividing the totals by the total number of brains examined in the entire group. The general averages, shown in the two bottom lines, of the absolute weights of the several parts at all ages, from twenty years upwards, have been arrived at in a similar manner.

In order fully to utilise the information contained in Tables VII. and VIII., it was necessary to ascertain the stature-ratios of the encephalon and its parts, which is done, as before, by dividing the average weights of those parts by the mean heights in inches, in each of the three groups. It has been found by Dr Boyd, and I have verified his conclusions, that the three

groups of males, 70, 67, and 63 inches, and the three groups of females, 65, 62, and 59 inches, may be accepted as practically representing the mean heights of the individuals in the six several groups respectively. The following interesting tables of stature-ratios are the result.

TABLES IX. and X.

Tables showing the encephalic stature-ratios, or ratios of the weights of the encephalon and its parts, to the stature in 1857 persons, male and female, sane and insane, the same as those to which Tables V. to VIII. relate. They are arranged, as before, in three horizontal divisions according to age, and three vertical divisions according to the stature. The cerebro-cerebellar ratios are also given at each age, and at the several heights. Lastly, at the bottom, are the general ratios at all ages at the different heights. Roman and Old Style figures are again employed to distinguish the sane from the insane.

Males.

Ages.	Stature 69 In. and upwards. Ratios of Weight to every Inch.					Stature 68 to 66 Inches. Ratios of Weight to every Inch.					Stature 65 In. and under. Ratios of Weight to every Inch.				
	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	Ratios of Cerebrum to Cerebellum.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	Ratios of Cerebrum to Cerebellum.	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	Ratios of Cerebrum to Cerebellum.
20–40	·710	·620	·075	·014	8·2–1	·716	·625	·076	·015	8·2–1	·737	·653	·07	·014	7 –1
	·695	·600	·079	·016	7·5–1	·719	·625	·078	·015	7·9–1	·726	·630	·08	·016	7·8–1
40–70	·688	·601	·073	·014	8 –1	·702	·612	·076	·014	8 –1	·725	·633	·078	·014	8·1–1
	·682	·589	·077	·016	7·6–1	·687	·594	·078	·015	7·6–1	·719	·625	·078	·016	8 –1
70–90	·670	·588	·068	·013	8·5–1	·686	·598	·073	·015	8·2–1	·699	·612	·073	·014	8·3–1
	·672	·583	·073	·014	7·9–1	·686	·597	·074	·015	8 –1	·681	·586	·078	·017	7·4–1
20–90	·691	·605	·072	·014	8·3–1	·703	·613	·075	·015	8·1–1	·723	·632	·077	·014	8·1–1
	·685	·592	·077	·015	7·6–1	·699·	·606	·077	·015	7·8–1	·718	·623	·079	·016	7·8–1

Females.

Ages.	Stature 64 In. and upwards. Ratios of Weight to every Inch.				Ratios of Cerebrum to Cerebellum.	Stature 63 to 61 Inches. Ratios of Weight to every Inch.				Ratios of Cerebrum to Cerebellum.	Stature 60 In. and under. Ratios of Weight to every Inch.				Ratios of Cerebrum to Cerebellum.
	Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.		Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.		Encephalon.	Cerebrum.	Cerebellum.	Pons, &c.	
20–40	·686	·602	·072	·012	8·3–1	·697	·605	·078	·014	7·7–1	·715	·623	·078	·014	7·9–1
	·661	·572	·074	·015	7·7–1	·676	·583	·077	·016	7·6–1	·662	·572	·074	·016	7·7–1
40–70	·655	·572	·071	·012	8 –1	·688	·601	·073	·014	8·1–1	·718	·628	·076	·014	8·1–1
	·658	·571	·072	·015	7·8–1	·689	·597	·077	·015	7·7–1	·711	·619	·076	·016	8 –1
70–90	·632	·550	·069	·013	7·9–1	·641	·555	·073	·013	7·6–1	·659	·572	·073	·014	7·9–1
	·673	·584	·074	·015	7·8–1	·665	·572	·077	·016	7·4–1	·661	·572	·073	·016	7·9–1
20–90	·657	·574	·071	·012	8 –1	·682	·594	·074	·014	7·9–1	·713	·613	·076	·014	8 –1
	·660	·572	·073	·015	7·8–1	·685	·592	·077	·016	7·6–1	·696	·606	·074	·016	7·9–1

In examining the preceding six tables, from V. to X. inclusive, I may, by a slight digression, first dispose of certain contrasts which they present between the sane and the insane.

Although Parchappe found that in the cases of insanity which he first examined, the brain was on the whole larger than in the sane in both sexes, but especially in men, he subsequently detected the fact that in advanced forms of insanity, the brain became smaller than in the sane at corresponding ages. Dr Skae, again, found that the brain-weight in the insane was greater than in the sane. Dr Thurnam and others, even Parchappe himself, endeavour to explain these discrepancies by reference to the influence of different forms of insanity, differences of class, and other causes. Dr Skae, in particular, pointed out that the weight of the cerebellum was often increased in insanity, and attributed the increased weight of the entire encephalon to this circumstance; but, in the weight of the cerebellum, he included that of the pons with the medulla oblongata. Since, however, the question of the influence of stature has been by these and all other observers disregarded, or rather uninvestigated, some interest, it will be admitted, attaches to an examination of the subject with this additional aid to the research.

In Tables V. and VI. it is seen that, in the 42 instances of comparison between the sane and the insane, of corresponding mean stature as well as of corresponding mean age, in the two

sexes, the cerebrum is smaller in the insane in 26 instances, whilst the cerebellum is larger in the insane in 31 instances. In regard to each organ there are a few examples of equality, or of a very close approach to it. The pons and medulla are larger in the insane in 34 instances, and equal to those of the sane in the remaining 7 instances. The entire encephalon is just as frequently larger as it is smaller in the 42 instances.

Again, in Tables VII. and VIII., in the 18 instances of comparison therein contained, it is seen that in the insane, as contrasted with the sane, the cerebrum is smaller in 14 and equal in 1; the cerebellum is, on the contrary, larger in 13 and equal or almost so in 3; the pons with the medulla is larger in 16 and equal in the other 2; and, lastly, the entire encephalon is smaller in 10, equal in 1, and larger in the remaining 7. Moreover, if we compare the results of the six pairs of total averages in the bottom lines of these two tables, the insane cerebrum is the smaller in all 6 instances; the insane cerebellum is the larger in 5 instances, and almost equal in 1; the insane pons and medulla is larger in all instances; and the insane entire encephalon is smaller in 4 instances out of the 6.

Now, as the mode in which these data have been obtained includes a classification of all the cases, both sane and insane, according to stature, it is certain that we may now conclude, without the fear of being deluded by any fallacy attributable to its influence, that in a given number of persons dying afflicted with all the various forms of insanity, the cerebrum is more commonly smaller, the cerebellum still more frequently larger, and the pons with the medulla almost invariably larger, and never less, than in the sane condition. As to the entire encephalon, this is smaller or larger with nearly equal frequency.

The stature-ratios of the several parts of the encephalon, and of the encephalon itself, given in Tables IX. and X., are necessarily quite accordant with these conclusions; but they, moreover, serve to correct any erroneous inferences which might be formed from a comparison of the cerebro-cerebellar ratios, at the different periods of life, and at the different heights of the body, in the sane and the insane. These last-named ratios show, for example, that, with three exceptions, the proportion of cerebrum to cerebellum is invariably smaller in the insane than

in the sane; in two of these cases of exception it is equal, and in one only is it less. In the general averages recorded at the bottom of the table, it is seen that in the males the cerebro-cerebellar ratio ranges in the sane from 8·1 to 8·3 to 1, and in the insane from 7·6 to 7·8 to 1; in the females, the same ratio varies from 7·9 to 8 to 1, whilst the insane ratio ranges from 7·6 to 7·9 to 1. But it is obvious that this difference in the ratios may be otherwise expressed, viz., that the proportion of cerebellum to cerebrum is larger in the insane. In by far the greater number of the instances noted in the tables, it is undoubtedly due to opposite deviations as to size in both of the organs concerned. By comparing their respective stature-ratios, in the sane and the insane, it is, however, at once made plain that, considering the size of each organ, the cerebellum is increased in insanity far more than the cerebrum is diminished, the former organ being increased, on a general average, by about $\frac{1}{25}$th part of its weight in the males and by $\frac{1}{35}$th part in the females, and the latter organ being diminished by about $\frac{1}{65}$th part of its weight in the males and by $\frac{1}{145}$th part in the females. The male cerebellum, therefore, as thus tested, increases more than the female cerebellum, whilst the male cerebrum diminishes more than the female cerebrum, under the influence of insanity generally. Hence, as is seen on consulting Tables IX. and X., the cerebro-cerebellar ratio deviates more from the healthy standard in the male series than in the female series of the insane.

The further prosecution of this subject I have left in the hands of specialists; but it may be here stated generally, that an analysis of the MS. data, from which I constructed Tables III. and IV., shows that in mania and recurrent mania the cerebrum is, on an average, larger than normal; in melancholia it is slightly above the normal size; whilst in general paralysis, dementia, and fatuity it is below the average. In epilepsy it is below the normal in the males, but above it in the females. On the other hand, the cerebellum is, in all forms of insanity (excepting in fatuity in the males only), larger than in the sane, but especially so in mania, recurrent mania, and melancholia; it is likewise so, in general paralysis and dementia, and even in fatuity in the females. The entire

encephalon is heavier only in mania, recurrent mania, and melancholia. Dr Boyd's more complete analyses of his data will, I believe, confirm these conclusions.

The digression which I have been tempted to make has brought out facts which serve in part to explain the discrepancies amongst the different observers above alluded to, as to the weight of the entire brain in insanity. The effects of difference of nationality, class, and education may explain the rest. It is certain that the test of stature, or the correction dependent on the stature equation, as applied herein to the insane generally, should be also applied to persons labouring under the different kinds of insanity. In reference to the former, it proves most conclusively that any observed increase in the weight of the entire encephalon in the insane is not due to an increase in the cerebellum only; for, on consulting even the full Tables V. and VI., it will be found that in the instances in which this is the case, the cerebrum is, with only two trifling exceptions in the other direction, itself larger than in the corresponding group of the sane. As to the unequivocal evidence of deviations in the cerebrum and cerebellum of the insane, shown even when the effects of stature are duly considered and allowed for, they would seem to be of the greatest interest. The cerebrum, the organ of the higher mental faculties, becomes somewhat larger or heavier in the acute forms of madness; whilst in the chronic or exhaustive forms of insanity it becomes smaller or lighter. How far this is a physiological or a pathological deviation is for inquiry elsewhere. With regard to the cerebellum, it at least never loses weight or size in insanity; but, as a rule, and in all forms of mental disorder, and especially in the more active forms, it is even much enlarged. Has this a physiological or a pathological significance? If physiological, does this indicate some possible association of the cerebellar functions with our emotional as well as with our co-ordinated motorial activities? May its preponderance over the cerebrum precede and so imitate certain forms of insanity; and may this suggest the groundwork of preventive, corrective, or curative treatment, by the employment of strictly intellectual training on the one hand, and of simple corporeal exercises on the other, so as to check or divert the

action of the over-developed or over-developing cerebellum? If pathological, does this indicate a relatively greater amount of chronic inflammation and condensation of the neuroglia of the cerebellum than of the cerebrum.

Reverting now to the general consideration of the facts recorded in the Tables V. to X., in which the influence of stature is specially eliminated from that of age and sex, it may be noted, in the first place, that, as the ascertained mean stature in the male sex is about 66·5 inches, and that in the female sex about 62 inches, it follows that in each of these tables, the central group of the vertical series contains, as nearly as may be, the normal weights and normal stature-ratios of the encephalon and its parts, and the normal cerebro-cerebellar ratios, for persons of mean stature in the two sexes. This applies equally to the insane and to the sane.

In the second place, if it be desired to test the size of any individual encephalon and its parts, these may at once be compared with the average weights of those organs, given in Tables V. and VI., for persons of corresponding age and stature, according to the sex; and, in this manner, a safer basis is obtained for determining any individual deviation from the normal weights. In the case of the late Mr Grote's brain, for example, this was precisely the test which, being required, could not be obtained. In the third place, an examination of the fuller Tables V. and VI., and of the condensed Tables VII. and VIII., shows at a glance the respective influences of sex, age, and stature, more accurately defined from each other by separating that of stature in the manner already explained, the advantage of which is thereby illustrated. The effects of age, in the two sexes, are traceable by following the perpendicular columns of figures; and those of stature by tracing the corresponding numbers along the horizontal lines. Unless where the cases examined are too few, the progression of the several *absolute* weights vertically and horizontally is very regular. These absolute weights are seen to diminish with age, and also with a decrease of the stature, in the manner already described.

As to the *relative* weights of these several parts, when compared with the stature, or their stature-ratios, which are exhibited in Tables IX. and X., it is not only shown that these

become less at the higher statures in both sexes, but it is also evident that not only are the encephalon and its parts absolutely heavier in the male than in the female, but also relatively heavier in reference to the height of the body; and this is true at all ages and at all heights. Even at equal or nearly equal heights, as, for example, in the male group at 65 inches and under, and the female group at 64 inches and upwards, the relative preponderance of the male encephalon and its parts, as tested by reference to the stature, becomes more apparent; for, in this case, the effect of stature is towards increasing the ratio in the male series, but towards diminishing the ratio in the female series. Another reference to Tables VII. and VIII. will show, moreover, that the encephalon and its parts are also absolutely heavier in the shortest males than in the tallest females, although their actual heights are approximately similar. The sexual character, in fact, overpowers the influences of stature.

It will be observed that as the effect of increasing age is to diminish the brain not only absolutely but relatively to the height of the body, which remains practically unaltered, and as the effect of increasing stature is to increase the brain absolutely, but to diminish it relatively, so the joint effect of increasing age and increase of stature is greater than either of these causes operating by itself. Hence, the lowest proportion of brain to the body is to be found in the tallest and oldest persons of either sex (see the left-hand bottom corners of Tables IX. and X.), and the highest proportion of brain in the shortest and youngest persons (see the right-hand top corners of those tables).

In the fourth place, we may employ the data collected together in the preceding tables, for the purpose of separating and expressing in more precise terms, and indeed numerically, as shown in the following tabular statement, the several effects of sex, age, and stature on the absolute weights of the encephalon and its parts, and on the relative weights of those parts in reference to the body as measured by its height.

(1) *Effects on the Absolute Weights of the Parts.*

On the Encephalon.									
Of Sex.			Of Age.			Of Stature.			
		Oz.	Years.	Males.	Females.	Inches.	Males.	Inches.	Females.
Total Adults at all Ages and Heights.	Males, .	47·05	20–40	48·55	43·29	70	48·4	65	42·76
	Females, .	42·22	70–90	45·7	40·1	63	45·6	59	41·53
	Differences,	4·83	...	2·85	3·19	7	2·8	6	1·23
On the Cerebrum.									
Total Adults at all Ages and Heights.	Males, .	41·08	20–40	42·16	37·71	70	42·34	65	37·32
	Females, .	36·77	70–90	39·96	34·86	63	39·84	59	36·17
	Differences,	4·31	...	2·20	2·85	7	2·5	6	1·15
On the Cerebellum.									
Total Adults at all Ages and Heights.	Males, .	5	20–40	5·09	4·73	70	5·09	65	4·62
	Females, .	4·59	70–90	4·45	4·47	63	4·87	59	4·5
	Differences,	·41	...	·64	·26	7	·22	6	·12

Of Sex, Age, and Stature combined.

	Years.	On the Encephalon.	On the Cerebrum.	On the Cerebellum.
In Males, . . .	20–40 at 70 inches,	49·72	43·43	5·29
,, . . .	70–90 ,, 63 ,,	44·15	38·6	4·65
	Differences, .	5·57	4·83	·64
In Females, . . .	20–40 at 65 inches,	44·64	39·14	4·7
,, . . .	70–90 ,, 59 ,,	39·59	34·36	4·36
	Differences, .	5·05	4·78	·34

(2) *Effects on the Weights of the Parts relatively to the Stature.*

On the Encephalon.									
Of Sex.			Of Age.			Of Stature.			
		Oz.	Years.	Males.	Females.	Inches.	Males.	Inches.	Females.
Total Adults of all Ages and Heights.	Males, . .	·706	20–40	·721	·699	63	·723	59	·713
	Females, .	·680	70–90	·685	·647	70	·691	65	·657
	Differences,	·026	...	·036	·052	7	·032	6	·056

(2) *Effects on the Weights of the Parts relatively to the Stature*—continued.

On the Cerebrum.

Of Sex.			Of Age.			Of Stature			
		Oz.	Years.	Males.	Females.	Inches.	Males.	Inches.	Females.
Total Adults of all Ages and Heights.	Males, . .	·617	20–40	·632	·610	63	·632	59	·613
	Females, .	·593	70–90	·599	·562	70	·605	65	·574
	Differences,	·024	...	·033	·048	7	·027	6	·039

On the Cerebellum.

Total Adults of all Ages and Heights.	Males, . .	·075	20–40	·077	·076	63	·077	59	·076
	Females, .	·073	70–90	·071	·074	70	·072	65	·071
	Differences,	·002	...	·006	·002	7	·005	6	·005

Of Sex, Age, and Stature combined.

	Years.	On the Encephalon.	On the Cerebrum.	On the Cerebellum.
In Males, . . .	20–40 at 63 inches,	·737	·653	·07
,, . . .	70–90 ,, 70 ,,	·670	·588	·068
	Differences, .	·067	·065	·002
In Females, . . .	20–40 at 59 inches,	·715	·623	·078
,, . . .	70–90 ,, 65 ,,	·632	·550	·069
	Differences, .	·083	·073	·009

Proceeding now to summarise the various results above recorded, it has to be noted, that of the quite obvious increase in the *absolute* weight of the entire and sane encephalon, accompanying an observed increase in stature, the cerebrum, in both sexes, necessarily takes a larger share than the cerebellum. In the males, for example, the total increase in the encephalon at the higher stature amounts to 2·8 oz., *i.e.*, to somewhat more than $\frac{1}{16}$th of its weight at the lower stature; whereas the increase in the cerebrum alone is 2·5 oz., and in the cerebellum ·22 oz., *i.e.*, less than $\frac{1}{16}$th and about $\frac{1}{22}$nd of their respective weights at the lower stature. Or, again, the facts may be thus expressed:—The relative weights of the cerebrum and cerebellum being 8 to 1, the relative increase in the two organs, as above

indicated, is 11 to 1, so that the cerebrum not only absolutely, but even in reference to its own weight, increases rather more with increasing stature than the cerebellum in reference to its weight. In the insane, however, as we have seen, the reverse of this happens, owing chiefly to the exaggerated size of the cerebellum.

But, notwithstanding this increase in the absolute weight of the encephalon and its parts in obedience to an increase of the stature, it is shown, beyond doubt, by reference to the ratios in the second part of the preceding tabular statement, that the increase in the weight of the great nervous centres does no keep pace, *pari passu*, with the stature. On the contrary, there is a gradual and progressive relative diminution in the proportion of encephalon, or brain-substance, to the stature, as this latter itself increases. This condition reminds one of the well-known fact that, in the Vertebrata generally, but especially amongst Mammalia, the brain is proportionally smaller, as compared with the weight of the body, in the larger than in the smaller species, even when these belong to the same or to closely allied genera. This relative diminution in the size of the encephalon in taller individuals of the human race, it will be seen, is equally true, if we take the range of stature in both sexes together, or in either sex separately. It is evident that short persons of either sex have, proportionately to their height, a larger amount of brain than taller ones. Nevertheless, as shown in Tables IX. and X., and in the preceding summary, the proportion of brain to the stature always remains larger in the male than in the female, not only at the mean height or generally in both sexes, but even at corresponding or nearly corresponding heights, as, for example, in short men as compared with tall women; but the shortest women have a higher stature-ratio of brain than the tallest men. With this exception, the sexual superiority in the weight of the brain in the male, speaking generally, overrides the influence of stature—*i.e.*, it subsists in spite of his greater stature, which in itself would have a tendency to be associated with a proportionately smaller amount of brain.

Further comparisons show that the stature-ratio of the cerebrum diminishes less markedly and less uniformly than

that of the cerebellum, which latter organ, as already remarked, at least in the sane, obeys the influence of stature more exactly and implicitly, so far as regards its relative proportion to the weight of the body.

Enough has now been stated to show that unless the variations in the brain-weight accompanying differences of stature be eliminated or allowed for, no estimates of the effect of any other conditions which may influence the weight of the encephalon in Man, such as sex, age, race, occupation, education, mental qualities, or disease, can be regarded as altogether free from error. From this point of view many questions require to be reinvestigated; for, by such a method only can it be demonstrated what are the real effects of these and any other modifying causes.

The results above recorded would appear to indicate that, adopting the simplest numbers possible, the difference in absolute weight determined by sex, in the entire encephalon, is about $4\frac{3}{4}$ oz., or 10 per cent.; by age, as a mean in the two sexes, about 3 oz., or 6 per cent.; and by stature, as a mean in the two sexes, about 2 oz., or 4 per cent. It would seem, however, that the effects of age are more evident in women than in men, and that those of stature are more marked in men than women; the quantities in the former case being about $2\frac{3}{4}$ oz. and $3\frac{1}{4}$ oz., and in the latter about $2\frac{3}{4}$ oz. and $1\frac{1}{4}$ oz. The range of difference of stature in the two sexes is different, and, of course, this will partly account for its difference of effect on the male and female encephalon.

As to the weight of the cerebrum, the influences upon it of sex, age, and stature are similar to those which they exercise on the entire encephalon, that of age being more marked in women, and that of stature in men. But in reference to the cerebellum, the effect of age is much more marked in men than in women. Nevertheless, the joint effect of age and stature is greater in men, not only on the weight of the entire encephalon, but also on the weights of the cerebrum and cerebellum separately considered.

Moreover, on comparing the stature-ratios of these several organs, in the two sexes, at different ages, and at different heights, it is shown that, in regard to the entire encephalon,

these ratios are more influenced by age, in each sex, than they are by sex itself; and this is true of the stature-ratios both of the cerebrum and the cerebellum. Thus, the sexual differences of these ratios are, as regards the entire encephalon, as ·706 oz. in the male to ·680 oz. in the female; whilst the variation due to age is, in the male, as ·721 oz. to ·685 oz., and in the female as ·699 oz. to ·647 oz. Finally, the differences attributable to stature are as ·723 oz. to ·691 oz. in the male, and as ·713 oz. to ·657 oz. in the female; that is also greater than those due to sex, and about equal to those dependent on age.

It is obvious that other combinations of causes affecting the brain-weight might here be recorded, as, for example, the effects of age at different heights, in both sexes; and, again, the effects of stature at different ages, in both sexes. But these could only be properly appreciated by employing very large numbers of observations. For there remains one other most important element of variation in the weight of the great nervous centres, which, in individual cases, and even as rendered apparent by the study of a very small number of instances, overpowers all other influences, and this is the proper tendency of the encephalon to vary in its developments as to size, in different persons. This residual peculiarity or deviation in the weight of the encephalon and its parts, especially of the cerebrum, in Man, might be called the *proper weight-variation*, or the *personal equation* of the weight of the brain or of the mere cerebrum, considered as an independent or quasi-independent organ.

It is a fact of the highest interest and importance that this personal difference, which can itself be duly estimated only when other conditions, whether of stature, age, sex, or race, are previously allowed for, is far larger, as will be immediately shown, than any of the variations already discussed. There exist, in fact, children with larger brains than many adults; there are certain women possessed of much larger brains than certain men; and there are certain short persons, both male and female, who have larger brains than certain tall ones; there are, indeed, some short women who have larger encephala than some taller men. Moreover, these individual peculiarities are equally observable in reference to the stature-ratios as well as in regard to the absolute weights of the brain and its several parts.

In order to estimate with some precision this most important condition, viz., the proper weight-variation, or individual tendency to variation in the weight of the encephalon and its parts, I will introduce here certain data also furnished me by Dr Boyd, arranged in the following tables.

Table showing the weights of the heaviest and of the lightest brains met with among 648 males and 698 females at 13 quinquennial periods of life. There are recorded, therefore, the weights of 26 selected male encephala, and of 26 selected female encephala. The numbers of persons from which the selection was made, at each period of life, averaged about 50. The heights of the corresponding individuals are also shown. (From the St Marylebone Infirmary.)

TABLE XI.

Ages.	Males.				Females.			
	Heaviest Brains.		Lightest Brains.		Heaviest Brains.		Lightest Brains.	
	Weight in Oz.	Height in In.	Weight in Oz.	Height in In.	Weight in Oz.	Height in In.	Weight in Oz.	Height in In.
20–25, . . .	54	68	29·2	64	46·8	66	36·8	62
25–30, . . .	57	69	41·5	65	45·8	63	35·7	48
30–35, . . .	57·2	66	33·7	65	43	68	36	61
35–40, . . .	*60·7	69	38·7	67	52	69	37·3	64
40–45, . . .	60	73	37·2	65	52·5	66	37	62
45–50, . . .	54	72	33·7	65·5	48·7	65	36·7	59
50–55, . . .	59	69	39	58	52·5	62	34·3	60
55–60, . . .	57	65	†30·5	63	51	64	37·7	61
60–65, . . .	59·5	68	38·5	66	*54	61	32·5	62
65–70, . . .	57·5	71	36·2	64	48	61	32·7	62
70–75, . . .	52·5	68	36	63	49·2	66	†29·3	48
75–80, . . .	55·2	72	37·7	67	49·5	62	35·7	61
80, &c., . . .	53·2	68	41	70	48	66	33·3	62
Averages, .	56·6	69	37·3	64·8	49·3	64·5	35	59·5

* Heaviest brains. † Lightest brains.

This table brings out in strong relief the individual element of variation in the weight of the brain, irrespective of the effects

of sex, age, or stature, showing clearly that, after all, this is the chief cause of the remarkable extremes of difference met with in the size of the human brain, and prominently displaying the comparative independence of that organ, as regards the bodily frame, in Man.

Thus, the extreme variation in the male series, according to the table, was from 30·5 oz. to 60·7 oz., *i.e.*, about 30 oz., or as 1 to 2; whilst in the female series it was from 29·3 oz. to 54 oz., *i.e.*, about 24·5 oz., or as somewhat less than 1 to 2. But, if we take the averages of the greatest and least weights, in each sex, at all ages, as shown at the bottom of the table, the range of variation in the 26 males was from 37·3 oz. to 56·6 oz., *i.e.*, 19·3 oz.; and in the 26 females from 35 oz. to 49·3 oz., *i.e.*, 14·3 oz. The great importance of these differential quantities is obvious, when we recall to mind that the sexual difference is 5 oz., that due to age about 3 oz., and that attributable to stature only about 2 oz.

The preceding figures further indicate that the individual tendency to variation in the brain-weight is greater in men than in women, the former sex being perhaps more subject to powerful disturbing agencies than the latter, which might be calculated to create and perpetuate such a distinction, in the shape of mental training, culture, exercise, and trial. As the range of stature in the males averaged 4·2 inches (69 = 64·8), and in the females 5 inches (64·5 = 59·5), it is obvious that not only does the male brain vary more than the female in its absolute weight, but also relatively to the stature.

The average stature-ratio, expressed as before in decimal parts of an ounce to 1 inch of the height, is, for the 13 heaviest male brains, ·82 oz., and, for the 13 lightest male brains, ·575 oz.; again, for the 13 heaviest female brains it is ·765 oz., and for the 13 lightest female brains it is ·59 oz. These results show that, not only as regards absolute weight, but also as regards the stature-ratio, the male brain varies more than the female brain, the amount of variation in the former being ·245 oz. and in the latter only ·175 oz.

It is obvious that the amounts of the different stature-ratios just mentioned, are regulated by the great and preponderating influence of the individual heaviness or lightness of the series of

brains here arranged together; so that in fact, certain apparently anomalous results are arrived at, viz., that the stature-ratio in the lightest male brains is less than in the heaviest female brains in the proportion of ·575 oz. to ·765 oz., although the stature is somewhat greater in the former series; and, again, the stature-ratio in the lightest female brains is somewhat greater than in the lightest male brains, ·59 oz. to ·575 oz., although the average stature in the former is really more than 5 inches less. But, it may easily be shown that, even in regard to these small numbers of selected cases, stature has exercised its own peculiar influence, as witness the following table relating to the same cases.

TABLE XII.

Table showing the stature-ratios of 13 heavy and 13 light male brains, and of 13 heavy and 13 light female brains, arranged in groups according to the stature of the individuals.

MALES.				FEMALES.			
Heaviest Brains.		Lightest Brains.		Heaviest Brains.		Lightest Brains.	
Height in Inches.	Stature-ratio.	Height in Inches.	Stature-ratio.	Height in Inches.	Stature-ratio.	Height in Inches.	Stature-ratio.
73	·822	70	·585	69	·753	64	·584
72	·77	67	·576	67	·632	62	·566
71	·838	66	·582	66	·75	61	·6
69	·844	55	·582	65	·75	60	·571
68	·830	64	·60	64	·79	59	·622
66	·867	63	·55	63	·73	48	·676
65	·867	58	·67	62	·836		
				61	·836		

The numbers in this table show clearly that within each group of heavy and light brains, the ratio of the brain-weight to the stature is greater in the shorter than in the taller persons

of each group; and, moreover, that the progressive increase in that ratio from the upper or taller, to the lower or shorter individuals in each column is tolerably regular.

But we may terminate the illustrations of the influence of stature on the brain-weight by another table also derived from Dr Boyd's manuscripts.

TABLE XIII.

Table showing, out of the same 648 males and 698 females, as were made use of in the construction of Table XI., the height of the body and the weight of the brain, in the 13 tallest and the 13 shortest males and females, met with at different quinquennial periods of life. The average number of cases in each group was 50.

Ages.	MALES.				FEMALES.			
	Tallest.		Shortest.		Tallest.		Shortest.	
	Height.	Weight.	Height.	Weight.	Height.	Weight.	Height.	Weight.
20–25	70	48·4	64	46·3	66	46·8	57	39·7
25–30	72	48·7	64	45·9	66	49·3	48	35·7
30–35	72	57·2	50	50·5	68	50·5	54	43·7
35–40	74	53·3	58	55·5	71	41·5	58	42·5
40–45	73	53·2	62	47·6	67	39·8	58	44·2
45–50	72	50·9	54	44	67	42	58	39
50–55	74	48·7	58	39	66	40·3	57	47·7
55–60	72	48	60	45	69	41	54	41·5
60–65	74	41·3	60	49·5	67	43	56	38
65–70	72	46	63	50	67	39·6	54	46
70–75	73·5	44·7	62	45·6	69	49	48	38·9
75–80	72	49·7	60	38·5	66	38·2	55	38
80	72	46	62	47·2	67	39·6	54	41·7
Aver.	72·5	48·9	59·75	46·5	67·4	43·1	54·7	41·27

The average heights and weights shown in the bottom line of this table, indicate that the absolute weight of the brain is greater in the groups of tallest males and females than in the groups of shortest males and females. The average weight amongst the tallest males is 48·9 oz., in the shortest 46·5 oz.; whilst the average weight in the tallest females is 43·1 oz., and in the shortest only 41·27. The difference between the two groups of males is 2·4 oz., and that between the two groups of females is only 1·83 oz.; and as the differences in the average statures are shown to be the same, viz., 12·7 inches, it is evident that the range of absolute variation between tall and short individuals, is greater in the male sex, a conclusion quite in harmony with the preceding statements.

On calculating the stature-ratios from the average heights and weights given at the bottom of the table, it is further shown, even in this small number of selected cases, that this ratio is higher in the shortest than it is in the tallest groups of the two sexes. Thus, in the tallest males it is only ·674 oz., but in the shortest it is ·778 oz.; whilst in the tallest females it is ·639 oz., but in the shortest it is ·754 oz. The difference between the highest and lowest stature-ratios, like the difference in the stature itself, being nearly similar in the two sexes, viz., about ·11 oz.

It is here also rendered evident that the average proportion of brain to the height of the body is, as has been already shown, greater in the male than in the female sex, notwithstanding the greater height of the former. This, moreover, is true, both as regards the tallest and the shortest of the two sexes. In the tallest, the male stature-ratio is, in round numbers, ·67 oz., whilst the female stature-ratio is ·64 oz.; in the shortest, the respective ratios are, as we have seen, ·78 oz. and ·75 oz. The mean stature-ratio for the 26 males is ·72 oz., and for the 26 females ·698 oz.

If, finally, we combine these 26 selected male and 26 selected female cases, into as small a number of groups as possible, corresponding with their heights, the following is the result.

TABLE XIV.

Table showing the stature-ratios of the brain-weight in 13 tall and 13 short males, and in 13 tall and 13 short females, arranged according to the heights of the individuals.

MALES.				FEMALES.			
Tallest.		Shortest.		Tallest.		Shortes	
Height.	Stature-ratio.	Height.	Stature-ratio.	Height.	Stature-ratio.	Height.	Stature-ratio.
74	·645	64	·720	71	·584	58	·716
73	·668	63	·793	69	·655	57	·768
72	·702	62	·788	68	·742	56	·68
70	·691	60	·755	67	·698	55	·69
		58	·814	66	·661	54	·813
		54	·814			48	·801
		50	1·05				

A glance down the columns of this table shows, that the stature-ratios, even in this small number of cases, are greater in the shortest individuals of either sex than in the tallest of that sex; that they indicate, with here and there an exception, a regular increase of the stature-ratios in each group, from above downwards in each column, *i.e.*, in passing from the taller to the shorter individuals of each group; that the male ratios are, nevertheless, higher than the female ratios, although, of course, the heights themselves are greater in the males; and that, with one exception (viz., at the height of 54 inches), if we compare males and females of similar or nearly approximative height, the stature-ratio in the former is greater than the latter.

The numbers of cases included in Tables XII. and XIV., are too small to justify taking them as furnishing more than very interesting illustrations, of the relations between the stature and the brain-weight in either sex, and in the two sexes compared. It will also have been noticed that they relate only to the

weight of the entire encephalon. For more safe average results, we must again refer to Tables V. to X., to the comments on these, and to the summary of results given in pages 471 and 472. It is also from this alone that the modification of the stature-ratios on the cerebrum and the cerebellum can be definitely determined.

II. On the Relation between the Brain-Weight and the Mass of the Body.

The relations of the brain-weight to the stature, both in males and females, involving the comparison of data which are simple and tolerably exact, having thus been examined, it remains to discuss in the course of this paper the relation which probably exists between the brain-weight and the *mass* of the body in Man. This inquiry will necessitate the employment of more or less hypothetical elements. Of its great interest no doubt can be entertained, especially in reference to a strict comparison between the sexes as to the nobler cerebral endowments.

To decide whether the smaller so-called stature-ratio of the brain in the taller individuals of each sex, should be regarded as a sign of cerebral inferiority in them, and the greater stature-ratio in the shorter individuals, as one of superiority, and, again, whether the smaller stature-ratio of brain in woman, in spite of her lower height, is an indication of her relative cerebral inferiority, in comparison with man, requires a precise knowledge of the relations between the stature and the mass of the human body, in fully grown and well-proportioned persons of different heights, in both sexes.

Speaking generally, yet of standard examples only, the female skeleton and the female body also, being constructed after a more slender pattern than the male skeleton and body, are certainly lighter in proportion to their respective heights; and this may suggest an explanation of the facts that, whilst the difference between the weight of the male and female brain is greater proportionally than the difference between the male and female stature, it is less than the difference between the weight of the male and the female body. As already stated by Parchappe and Thurnam, the statures of the male and female are as 1000 to 932, the ratio of their weights is as 1000 to 872,

and their encephalic ratio is as 1000 to 903; so that, as the last-named observer remarks, the ratio of the female to the male brain-weight is about 3 per cent. less than the ratio of their respective statures, but 3 per cent. more than that of their respective weights. That the woman has less brain in proportion to her height, but more in proportion to her weight, than man, is presumably owing to her mass being less bulky and therefore lighter than man's in proportion to her height. But is not the question herein involved open to a more definite solution?

The larger tables of M. Quetelet, recording side by side the stature and the weight of the human body, relate to individuals of different ages, from birth to the period of complete growth, but not to full-grown persons of different heights. Hence they illustrate only the growth of the human body, male and female, and its mean height and weight in the full-grown condition; whilst they throw no light on the actual variations which exist in stature and weight in individual adults. The mathematical formula invented by Quetelet for deriving the increment of the weight from that of the stature, and the curves, which, according to him, indicate the rate of increase of each, also refer to the case of growing, not of grown individuals. In a special table relating to females only, he places, side by side, the mean weights and heights of a large number of women, in groups according to their ages, from eighteen to forty; but there is evidently no necessary *individual* correspondence between the two series of numbers; so that the information is, only in a limited manner, applicable to the present inquiry. In regard to males, he admits that he has no sufficient data for satisfactory tabulation. Dr Boyd's records of the weight of the body after death are invalidated by the variable effects of different fatal diseases. In Gould's laborious returns concerning the height and weight of the soldiers of the United States army, better materials are to be found; but I prefer to employ those collected by Dr Beddoe, since they relate to inhabitants of the British Isles. I may add that, having examined the complicated methods employed by Krause, Harless, Meyer, and others, for determining the weights of parts of the body in relation to the whole, I do not find them available for the present purpose.

In pursuing this inquiry, I propose to regard the human body

as represented by a *rectangular parallelopiped*, or, as this was named by the late Professor de Morgan for shortness' sake, a *right solid*, supposed to be of uniform density, and having its longest dimension equal to the height of the body itself. In this manner, the mass of any given individual of good proportions, would be reduced to a hypothetical upright four-sided column of correspondent height, bounded by plain surfaces, and having a uniform density or specific gravity throughout.

Suppose, now, that the height of the hypothetical *male* right solid was 66 inches and its weight 138 lbs., or 2208 oz. av., and that the height and weight of the *female* right solid were 62 inches and 117 lbs., or 1872 oz. av., which numbers represent the results of the actual observations of Quetelet, as to the *mean height and weight* of the body in the two sexes, between nineteen and twenty-five years of age; then, on dividing the weight in ozs. by the height in inches in each case, the quotients, 33·4 oz. and 30·2 oz., evidently give the weights of a one-inch thick horizontal portion or slice of the male and female hypothetical right solids. These weights, which I will term the *inch-section-weights* of the male and female, afford a new measure of comparison between the sexes. Their ratio is 1000 to 904, thus, as might be anticipated, falling between the simple stature-ratio 1000 to 948, and the weight-ratio 1000 to 847, obtained from the heights and weights just mentioned and employed in the determination of the respective inch-section-weights, and almost exactly corresponding with the brain-ratio given by Thurnam from Dr Boyd's observations, viz., 1000 to 903. Limiting the comparison between the sexes to average or *mean* examples, it appears therefore that whilst women have 4·5 per cent. less brain in proportion to their stature, and 5·2 per cent. more in proportion to their weight, they have only 1 per cent. less in proportion to the *inch-section-weight of the mass of their body.* Adopting this as a reasonable method of comparison, the sexual difference, as regards cerebral endowments, is shown to be insignificantly small.

It is obvious that the masses of the male and female right solids here imagined, may also be represented by their volumes in cubic inches, in which case, their transverse or *horizontal sections* would be measurable in square inches. Thus, the

weight in oz., multiplied by 1·73, the number of cubic inches in 1 oz. of water, and divided by 1·08, which I have found experimentally to be the specific gravity of the body, would give the volumes of the right solids in question in cubic inches; and these volumes, divided by 66 and 62 inches respectively would give, in each case, the number of cubic inches in each horizontal portion or slice, 1 inch in thickness, and also, of course, the number of square inches in the horizontal sectional area of each right solid. But the ratios of these last quantities in the two sexes, would necessarily be precisely the same as the ratios of their respective inch-section-weights; so that the calculation need not here be further pursued.

The inch-section-weights of the *average* full-grown male and female, viz., 33·4 oz. and 30·2 oz., are, it will be observed, numerically almost equal to one-half the number of inches in the mean stature of each sex respectively. On the supposition that a common, or, as it were, ideal standard of proportional development in Man existed independently of sex, and that, according to this, the inch-section-weight in oz. should exactly equal half the height in inches, *i.e.*, should be 33 oz. and 31 oz. at the mean male and female heights, 66 inches and 62 inches respectively, the numbers just quoted, as derived from the observed mean heights and weights, would be somewhat above such standard in reference to the male, but more decidedly below it as regards the female. Such a result would accord with the fact that the female frame is, even relatively to its stature, smaller than the male frame, and necessarily has, height for height, a smaller horizontal section. Each sex might, as it were, be supposed to deviate, in the progress of its development, from an imaginary intermediate and neutral standard of proportion, in accordance with its special destiny and mode of differentiation, the male keeping very much nearer to it than the female, whose deviation from it, as will presently be shown, is the more remarkable.

The calculations already made, terminated in a comparison between the mean heights and weights of the body, the mean inch-section-weights, and the mean brain-weights of the sexes, as expressed in certain ratios; but, we may now further ask, what are the effects of differences of stature on the weight of

the body, on the weight of the inch-section, and on the weight of the brain, as shown by an examination of these points in groups of individuals of different height, belonging to each sex. In this inquiry, it becomes impossible to employ ratios as tests, since the data are necessarily much fewer in each category or class under examination; but sufficient contrasts may be obtained by resorting to direct comparisons of the observed and calculated quantities, in each case.

As regards the *male* sex, for example, the first part, A, of the following table, compiled from the data collected by Dr Beddoe, shows the *observed* weight of the body in lbs. and in oz., and also the actual inch-section-weight, in men of different heights, from 70 downwards to 62 inches. In the second part of the table, marked B, are given the *calculated* weights of the body, at the corresponding heights, on the supposition, already indicated above, that the number of oz. in each inch-section of the equivalent hypothetical right solid, was exactly equal to half the number of inches in the height.

TABLE XV.—*Males.*

Height in inches.	70	69	68	67	66	65	64	63	62
A. Observed Mean Weights.									
Weight of body in lbs.,	164	153	147	142	138	133	125	121	?
Weight of body in oz.,	2632	2456	2352	2280	2208	2128	2000	1936	?
Inch-section-weight in oz.,	37·3	35·6	34·6	33·9	33·4	32·7	31·2	30·7	?
B. Calculated Weights.									
Weight of body in lbs.,	153	148·75	144·5	140·25	136	132	128	124	120
Weight of body in oz.,	2450	2380	2312	2244	2178	2112	2048	1984	1922
Inch-section-weight in oz.,	35	34·5	34	33·5	33	32·5	32	31·5	31

On comparing the two series of numbers in A and B, it is seen that the calculated results approach very nearly to the results of observation. This is especially observable at the heights of 67, 66, and 65 inches; 66 inches being, as already stated, the mean height or standard proportion of the male sex. At this height, also, it is seen that the weight of the body, and consequently the inch-section-weight derived from Dr Beddoe's observations, exactly coincide with those already quoted as obtained from Quetelet's data. Above 67 inches, the observed weight and inch-section-weight rise above, whilst below 65 inches, they fall below the calculated quantities.

The weight of the living human body is, however, a very variable factor, and one exceedingly difficult to determine with accuracy, or to estimate correctly. The popular estimates are usually much too high. Even the naked weight is influenced by the presence of more or less food, and of solid and liquid excreta, which are actually extraneous to the body, regarded as an active machine governed by its nervous centres. Moreover, unless in the case of trained persons, who always lose weight at first, from the diminution of redundant subcutaneous or internal fat, or of persons, like prisoners and others, who are subjected to a scientifically balanced diet and occupation, it may be said that one cannot obtain an observation of the *pure* or *normal* weight of the body. This difficulty may be illustrated by reference to the differences observed in the wild and domesticated condition of any given animal. Again, in such a comparison as that now instituted, the weight of the cerebrum itself might, with propriety, be deducted from the total weight of the body, before the proportion of one to the other should be attempted to be shown. On one or other, or all of these grounds, therefore, it seems to me that all the observed body weights might be reduced somewhat, in which case the slight discrepancy between the *central* or *mean* observed weight at 66 inches, and the corresponding calculated body weight would disappear.

Again, it is not unreasonable to conclude that, as the taller men, in the struggle for existence in a civilised community, would fall into positions requiring more physical labour, the weights of their bodies, as found by Dr Beddoe, should have a tendency to be relatively heavier, even in proportion to their

height, as compared with the shorter men, in which class, Dr Beddoe found that most criminals were included, who would either be living a very precarious life, or be fed on prison fare. It, of course, would be expected that the development of the nervous centres would chiefly follow that of the muscular system, next that of the skin and other organs of sensation, and only in a very remote manner that of the viscera; whilst it would have no relation of importance to the growth of adipose tissue, which, on the other hand, would be more likely to abound in well-grown, well-employed, and well-fed men than in their less favoured and very demoralised fellow-creatures.

From these considerations, it would seem justifiable to reduce somewhat the observed weights of the taller men, and increase slightly those of the shorter men, in Dr Beddoe's series, and thus bring each class nearer to the calculated weights. Nevertheless, the taller men would still exceed, and the shorter men fall short of, the herein supposed standard proportion of weight to height. This would coincide entirely with what has already been noticed in comparing the taller body of the male with the shorter body of the female; and it, moreover, agrees with, if it does not explain, the smaller stature-ratio of brain in tall men as compared with short men, which might be regarded as due, not to deficiency of brain, but to excess of body-weight in the former.

On proceeding to make further use of the method of calculation above described, I found, quite unexpectedly, that, in the case of the *central point of stature*, or *mean height* of the *male* body, viz., 66 inches, if the weight of the equivalent right solid in oz. be divided by the number of square inches in its horizontal section, the result gave, within a small decimal part of an oz., the weight, not of the entire encephalon, but of the *cerebrum*, in *males* of corresponding stature. Thus, 66 inches being the height of the hypothetical male right solid, 33 oz. is the supposed weight of each of its transverse inch-sections or slices, and 2178 oz. its total weight (see Diagram A, p. 497). Then 33 ozs., or the inch-section-weight, multiplied by 1·7 (the number of cubic inches in an oz. of water), and divided by 1·08 (the specific gravity of the human body), or, what is the same thing, 33 ozs. multiplied by 1·6, gives 52·8 cubic inches as the

volume of each inch-section, and, therefore, 52·8 square inches as the area of the horizontal section of the right solid in question. But 2178 oz. divided by 52·8 = 41·25 oz., and on referring to Table VII. in this memoir, compiled from Dr Boyd's observations, it is seen that the average weight of the *cerebrum* in the 598 sane *males*, whose *mean stature* would be 66 inches, is 41·1 oz., showing a difference of only ·15 oz.

This can hardly be considered an accidental coincidence. The result follows from the consideration and use of *mean* or average quantities. The one assumption made in obtaining it, consists in the supposed relation of the inch-section-weight to the height; but the 33 oz. assumed is within ·4 oz. of the observed quantity, and that implies a difference of only 2 lbs. weight in the entire body, which may be owing to error of observation, to excess of fat, or to the inclusion of extraneous matters in the observed body-weight. The numbers would seem to point to a definite relation between the weight of the *cerebrum* and the mass of the body, this mass being expressed by its horizontal section, which is itself dependent on the ratio of its weight to its stature. The importance of the stature as a basis of calculation becomes thus apparent; and it can hardly be doubted that in a well-proportioned man, some definite relation must exist between this and the mass of the body, and also between the latter and the size of the great nervous centres; for, even in the most complex organisms, proportion of parts is never absent.

The following table is designed to show some further results of this method, as applied to estimating the cerebral weight in males of different stature, varying, on either side of the mean height of 66 inches, between the heights of 60 and 70 inches. The observed weights of the cerebrum are placed beneath the calculated weights, in each case.

[TABLE XVI.

TABLE XVI.—*Males.*

a. Height of body in inches, . .	72	70	68	66	64	62	60
b. Weight of body in oz., . . .	2592	2450	2312	2178	2048	1922	1800
c. Inch-section weight in oz. of equivalent right solid,	36	35	34	33	32	31	30
d. Horizontal section in square inches of equivalent right solid,	57·6	56	54·4	52·8	51·2	49·6	48
Calculated weight of cerebrum, *i.e.*, *b* divided by *d* in ozs.,	45	43·75	42·5	41·25	40	38·75	37·5
Observed weight of cerebrum from Dr Boyd's data,	* 43·75	* 43·22	42	41·1	40	39·4	* 38·5

* These numbers are taken from very few observations.

This table shows that, not only at the mean height of 66 inches, but for heights 4 inches above and below that mean, the weight of the cerebrum, as estimated in the manner here employed, agrees very nearly with the results of actual observation. Above that range of stature, however, the calculated cerebral weight is greater than the observed weight, whilst below that range it is less; in other words, the actual cerebral weight, as thus compared with the mass of the body, regarded from the point of view of its hypothetical horizontal section, is smaller in tall, and larger in short men, a conclusion in harmony with the facts already stated, viz., that the body-weight of tall men is, relatively to their stature, heavier than that of short men, and also that the stature-ratio of their entire encephalon is less.

As regards the *female* sex, no sufficient data exist, from which to ascertain the relations between the stature and the weight, in individuals of different heights; so that our consideration of those relations must be mainly directed to the case of the *mean stature* and *mean weight* of the full-grown female. According to Quetelet, the mean stature of women, between nineteen and twenty-five years of age, is almost exactly 62 inches. For this height, adopting the same basis of calculation as that employed in the case of the male body, the inch-section-weight would be 31 oz., and the equivalent female right solid would weigh 1922 oz. or 120 lbs. Now this would give, as is seen recorded in the male series in Table XVI., 49·6 square inches for the horizontal sectional area; and, accordingly, 1922 oz. divided by 49·6, *i.e.*,

38·75 oz., would be the calculated mean weight of the cerebrum (see Diagram B, p. 497). But the observed mean weight of the female cerebrum, in individuals of mean stature, and at twenty years of age, is 37·23 oz. or 37·8 oz. (see Tables II. and VIII.); so that, on the preceding estimate, the female brain would appear to be, as contrasted with the male brain, deficient in relation to the mass of her body.

It is, however, as before observed, quite certain that the female body is constructed after a lighter model or pattern, and that height for height it weighs less than the stronger male frame. Turning, indeed, to the tables of Quetelet, it is found that the mean weight of women of the mean height of 62 inches, and of the age of twenty years, is 117 lbs., and on the ground of error due to excess of fat, or the inclusion of extraneous matters, it is not unjustifiable to reduce this to 116·25 lbs. or 1860 oz. Now, this would give for the inch-section-weight of the hypothetical female right solid 30 oz., and for the horizontal section 48 square inches. But, again, 1860 oz. divided by 48 yields 38·75 oz., *i.e.*, the same result as before obtained, for the *calculated weight of the corresponding female cerebrum* (see Diagram C, p. 497). It is thus obvious that the method adopted for calculating the weight of the cerebrum in the male, cannot be applied directly to the determination of this factor in the female. The relation between the height and weight of the body, and therefore between the height and the horizontal sectional area, is peculiar or different in the female. As already stated, the female, even at her mean height, deviates thus in a remarkable manner from the male, who may be said to conform, at *his mean height*, exactly to the above assumed standard of proportion of height to weight, and therefore as to horizontal section. This latter quantity in the two sexes, at their respective *mean* statures, 66 and 62 inches, is seen to be as 52·8 square inches to 48 square inches, or as 33 oz. to 30 oz. (see Diagrams A and C, p. 497); but, at a given height in each sex, for example 62 inches, the horizontal sections of *the corresponding right solids* are as 49·6 to 48, or, more simply, as 31 to 30 (see Diagrams B and C, p. 497). But, as 31 : 30 : : 38·75 : 37·5, which is, therefore, the *corrected calculated* weight of the female cerebrum at the height of 62 inches; this almost exactly agrees

with the results of observation, for it falls midway between the two actually observed weights, viz., 37·23 oz. and 37·8 oz.

Hence, as in man, so in woman, the cerebrum appears to bear a definite relation to the section of the body, if this be regarded as an equivalent vertical right solid, such horizontal section being itself a resultant of the relations of its weight and height. Thus, we are finally led to the conclusion that, although a woman, judged by her height of body alone, has less cerebral matter, and judged by her weight of body alone, has more cerebral matter than man, yet, when both sexes are judged by an assumed common measure, which, in each, has reference to both those factors, their cerebral endowment is seen to be practically equal; so that the discrepancy which appears to exist in their cerebral ratio is thus fairly reconciled. The subjoined tabular statement of the calculated ratios will sufficiently illustrate this.

Calculated Ratios between the Mean Male and Female.

1. Ratio of stature, . . .	66 to 62 in.	1000 to 939
2. Ratio of weight, . . .	2178 oz. to 1860 oz.	1000 ,, 854
3. Ratio of inch-section-weight, .	33 oz. to 30 oz.	1000 ,, 909
4. Ratio of weight of the cerebrum,	41·25 oz. to 37·5 oz.	1000 ,, 909
5. Ratio of stature-ratio to weight-ratio,	939 to 854 oz.	1000 ,, 909

The ratio last enumerated necessarily follows from the first and second, and agrees with the third. The first and second are different from the ratios given from Parchappe; but, in my final judgment, are nearer to the truth as standard or mean numerical results. As to the fourth ratio in the preceding series, it is the most striking of all; it is also different from the corresponding ratio, viz., the brain-ratio recorded in p. 482; but that was *encephalic*, this is *cerebral*. Its coincidence with the sectional ratio stamps it with significance.

The true explanation of the differences as to cerebral endowment and power between the sexes, may possibly therefore be once more remitted to the absolute, rather than to the relative

amount of brain substance possessed by each, a brain mass of 1000, even if associated with a larger corporeal machine, being more vigorous and energetic, as a mental organ, than a brain mass of 909, associated even with a correspondingly smaller body.

It must now be mentioned, lest it should be supposed to be overlooked, that the circumstance of the agreement of the inch-section-weight in oz., with one-half the height of the right solid in inches, is a numerical coincidence, which would have no value whatever, unless it corresponded, as it does, so closely with the *observed* weight of the body divided by the *actual* inches of height. Being so, however, it greatly facilitates the required calculations. The essential relation, however, is that between the sectional area in square inches and the height in linear inches, of a right solid of uniform density; and, I need hardly add, that all the calculations, though in a different manner, can be worked on the metrical system, by the use of centimetres and grammes, as will be presently exemplified.

It is not here asserted, that the preceding method of estimating the normal proportion of cerebrum to the rest of the body is absolutely exact. It is meant only, that the method discloses the existence of a relation between the two things concerned, and serves to illustrate that relation by reference to numbers. Exactitude is at present impossible, and perhaps always will be; for the impulses of organic movements, even if subordinated to a rule capable of a mathematical expression, display ceaseless variety both in time and space.

The deviations from the assumed or calculated relation between the cerebrum and the body, taking place in one direction in tall persons, and in the opposite direction in short persons, so that an ascending line or curve, representing the actual weights, would be crossed by another ascending line representing the calculated weights, necessarily imply the existence of a place of concurrence or centre of true relation, just as the above described lines must intersect; and it is of consequence to note that, the point of coincidence between the observed and the calculated quantities, as recorded, for example, in Table XVI. for the male sex, in which alone they can at present be compared, occurs at or about the point of *mean*

stature for that sex. That the amount of these deviations at other heights may be partly reducible, by taking into account errors of observation, or an excess or deficiency of nutrient material, or of fat in the body, has been already suggested; but two other considerations, then deferred, may here be mentioned. On the one hand, the powerful inherent or intrinsic tendency of the nervous centres, and especially the cerebrum, to vary in size, may, in any individual instance, overbalance the general relation of proportion, in one way or the other; and, on the other hand, the body itself most probably sometimes departs, during the progress of growth, from its originally destined path of development, so that an intended tall man, with full-sized brain, has his stature dwarfed, and an intended short man, with a small-sized brain, has his height increased, by accidental causes, such as constitutional debility, illness, or accident; or, again, what may even more readily happen, persons of intended mean stature, with medium-sized brains, may, in their growth, vary in either direction. To eliminate the effects of such inevitable causes of deviation, a much larger number of observations would be required than are yet at command, of persons occupying the extremes of position as to stature; whereas, these are necessarily fewer than the observations of individuals at or near the mean height.

The following table exhibits the marked tendency of the cerebrum itself to individual variety, or personal equation, at each of the indicated statures.

TABLE XVII.—*Males.*

Heights in Inches, . .		72	70	68	66	64	62	60
Observed Weights of Cerebrum in the Male.	Greatest, . .	48	47	48	47	49	47	46·5
	Mean, . .	43·75	43·2	42	41·1	40	39·4	38·5
	Least, . .	38·25	36·5	36	35	36·5	32·5	34
Calculated averages,[1] .		43·3	42·23	42	41·03	41·83	39·63	39·66

[1] The author had not filled in the figures of the line of "calculated averages." The figures now inserted express the averages of the weights referred to in Table XVII., but it is possible that the figures 45 | 43·75 | 42·5 | 41·25 | 40 | 38·75 | 37·5 from Table XVI. may have been intended.—A.B.M.

Disclaiming the least desire to overrate the value of any of the preceding results, I will now attempt to show that a table of the estimated mean weights of the *entire encephalon* may be constructed, for persons of different stature, and of either sex from the relations already described as apparently existing between the cerebrum and the body.

It may first be pointed out that, as regards the *male* sex, the calculated weight of the cerebrum in individuals of any given height may be obtained in a less circuitous manner, than that already explained as the one by which this result was originally obtained. For, since the subdivision of the total weight of the hypothetical right solid by the number of square inches in its horizontal section, or *base*, is equivalent to the subtraction from that solid of a vertical column of equal height, and one inch square, *i.e.*, of an upright pile of cubic inches, equalling in number the inches of height, it is merely necessary, in regard to the *male*, to divide the number of inches of height by 1·6, the factor required to convert cubic inches of a substance having the density of the human body, into oz. av., to obtain the sought-for result.

Diagrams of Right Solids.

The annexed diagrams (p. 497) will serve to show this and other relations of the male and female hypothetical right solids described in this paper. As the quantities are marked on each figure, no special references to these are needed.

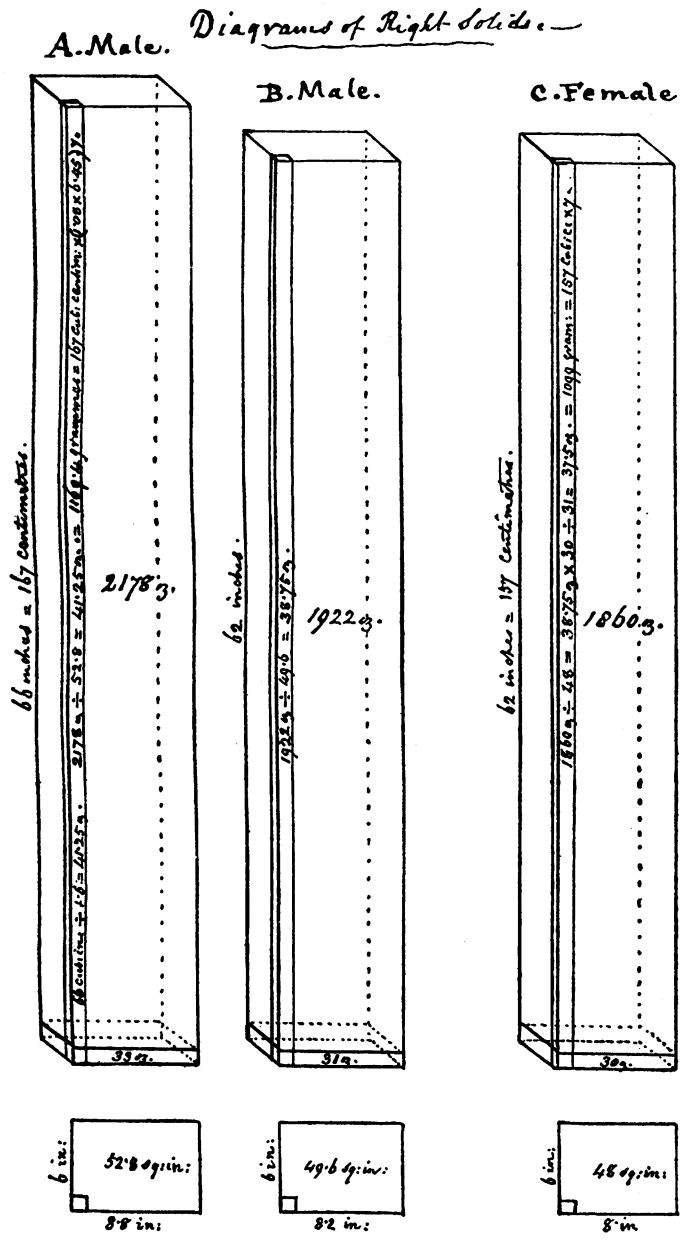
In figs. A and C, the various quantities are given in French measure also. Thus, 167 centimetres are, as nearly as may be, equal to 66 inches of height; a column of water, 1 square centimetre in horizontal section, and of that height, would contain 167 grammes weight of that fluid; and, as 1·08 is the specific gravity of the human body, $167 \times 1{\cdot}08$ will give the weight of a corresponding column of the equivalent right solid, viz., 180 grammes. But, as there are 6·45 square centimetres in 1 square inch, there would be 6·45 of such columns resting on a base of that size; so that $180 \text{ grammes} \times 6{\cdot}45 = 1169$ grammes, the weight of a column of the right solid, standing on a base measuring 1 square inch, and being 66 inches high; and that would be the calculated weight of the cerebrum in a man of

that stature. In all cases in *males*, therefore, the height in centimetres, multiplied by 1·08, and again by 6·45, or, what is the same, multiplied by 7, gives the estimated weight of the cerebrum in a male of similar height in grammes. It may be added that the calculated English cerebral weight in a male 66 inches high, *i.e.*, of mean stature, viz., 41·25 oz. av., is equal to 1169·4 grammes in French weight. This would give for the entire encephalon a weight of about 1350 grammes, which is a little below the average European weight, about 1380 grammes; but, in estimating this latter, the stature and its effects have not been observed nor allowed for.

Figs. B and C are introduced to show graphically that the mode of estimating the male cerebral weight is not applicable to the female, owing, as already explained, to the different relation between the sectional area and the height of the female right solid, as determined by her smaller total weight, *i.e.*, by her smaller and lighter frame, height for height. Thus it will be seen that, although the sectional area of the female right solid C, is only 48 square inches for a height of 62 inches, whilst the sectional area of the male of similar height is 49·6 square inches; yet, as the weights of these two solids, according to the method employed, are necessarily strictly proportioned to the sections respectively, viz., 1860 and 1922 oz., the division of the two latter quantities by the two former gives the same quotient, viz., 38·75 oz. Indeed, whatever the size of the sectional area, as it always bears the same relation to the weight when the height is equal, that quotient will be the same; and, as that always gives the weight of an identically sized column of the right solid, viz., one of 62 inches high, and 1 square inch in section, it could not properly represent the weight of the corresponding cerebrum under such numerous and widely different conditions. For, let the height be 62 inches, and the inch-section-weight either 30, 20, or 10 oz., then

$$\frac{62\times30}{30\times1{\cdot}6}, \text{ or } \frac{62\times20}{20\times1{\cdot}6}, \text{ or } \frac{62\times10}{10\times1{\cdot}6} = \frac{62}{1{\cdot}6} = 38{\cdot}75 \text{ oz.}$$

Finally, then, it is seen that, when the inch-section-weight in oz. is half the height in inches, the total weight in oz., divided by the sectional area in square inches, gives the calculated


Diagrams of Right Solids.
A. Male.
B. Male.
C. Female.
65 inches = 167 centimetres.
62 inches.
62 inches = 157 centimetres.
2178 c.
1922 c.
1860 c.
33 c.
31 c.
30 c.
6 in.
52·8 sq: in:
8·8 in:
49·6 sq: in:
8·2 in:
48 sq: in:
8 in.

weight of the cerebrum in oz., which, moreover, is also equal to the number of oz. in a four-sided column of the right solid in question, measuring 1 square inch in section, *i.e.*, containing as many cubic inches as the solid is high. This is the case in the male right solid of mean height, and with slight deviations, in male right solids of greater or less height. But it is not true of the female right solid. To find the corresponding calculated cerebral weight in that case, the proportion of the sectional area, or of the inch-section-weight, it does not matter which, to that of the male, has to be taken into account, and this will furnish the calculated weight of the female cerebrum. Thus, according as we compare the female of the mean height of 62 inches, with the male of the mean height of 66 inches, or with a male of the same height, viz., 62 inches, we have the following proportions as 33 : 41·25 oz. : : 30 : 37·5 oz., or as 31 : 38·75 oz. : : 30 : 37·5 oz.; in each case, the fourth term is the same, and gives the estimated weight of the female cerebrum at the mean stature. Using English inches for the height, and oz. av. for the weight, the following simple equations are all that are necessary:—

Weight of the mean male cerebrum, . $\frac{\text{Height}}{1{\cdot}6}$

Weight of the female cerebrum, . . $\frac{\text{Height}}{1{\cdot}6} \times 30 \div 31$

I here insert one more table, constructed on the bases already stated, to show the estimated weights of the body and of the *entire brain*, or *encephalon*, in full-grown males and females of different stature.

TABLE XVIII.

Heights in Inches, . .		72	70	68	66	64	62	60	58	56
Calculated Weight of Body in lbs.	Males, . .	162	153	144·5	136	128	120	112	...	...
	Females, . .	...	...	140	131·5	123·5	116	109	101·5	95
Calculated Weight of Encephalon.	Males, . .	51·6	50·23	48·8	47·35	45·9	44·48	43·05	...	...
	Females, . .	...	...	47·29	45·87	44·5	43·13	41·72	40·33	39·18
Observed Weight of Encephalon.	Males, . .	49·75	49·2	48·1	47·3	46·4	45·7	44·7*	...	...
	Females, . .	...	...	47	45·6	43·9	42·9	41·6	40·54	39·4

* This most discrepant result is taken from too few observations.

In compiling this table, the *calculated* weights of the male and female body are first obtained, and then the calculated weight of the *cerebrum* in each case is determined in the modes already explained. Next, the weights of the cerebellum, and of the pons with the medulla oblongata, are ascertained and added in each instance, so as to obtain the weight of the encephalon, or entire brain. The male cerebellum is supposed to be in the proportion of 1 to 8·1, and the female cerebellum as 1 to 8, in reference to the cerebrum; the pons with the medulla oblongata is assumed to be equal to $\frac{1}{5}$th part of the cerebellum. As to the *observed* weights of the encephalon at the corresponding heights, these have been obtained from some of Dr Boyd's observations, by taking, where possible, the mean of *three* adjacent groups of brains, always of individuals of from twenty to thirty years of age, and excluding very extreme cases of deficient weight, as a fair representation of the brain-weight of the middle group: thus, the tabulated weights at 66 inches and at 62 inches, for example, are obtained from the weights observed at 67, 66, and 65 inches, and at 63, 62, and 61 inches, respectively. Otherwise, the numbers employed at the required age would have been too few to have obtained tolerably fair results.

The observed and calculated weights correspond most nearly in the centre of each series, male and female; the former, as elsewhere noticed, are slightly defective at the higher, and excessive at the lower statures. The means of each series are as follows:—

Calculated weights—male, 47·34 oz.; female, 43·14 oz.
Observed weights—male, 47·0 oz.; female, 42·93 oz.

The numbers in this table may also be compared with those, at approximate heights, given in Tables VII. and VIII., with which, it will be seen, they show a remarkable concurrence.

Assuming that these results justify their use as a sort of scale of cerebral or encephalic development in Man, according to his stature, it would become possible to assign, more nearly than has yet been done, the proper relative position, as to weight, of any given person's brain, in reference to a certain *standard* or *normal* weight. In other words, its *proper weight-variation* could be at once determined; and this would indicate, so far as

size alone can do so, its individual superiority or inferiority, as compared with other brains.

For example, the observed weights of the brains of the following distinguished men, allowance being made for the effects of age in diminishing the weight in each case, were as follows:—

Thackeray.	De Morgan.	Babbage.	Grote.	Grant.
59 oz.	54·5 oz.	52·5 oz.	52 oz.	48·75 oz.

But the estimated standard weights, according to their respective statures, would have been:—

Thackeray.	De Morgan.	Babbage.	Grote.	Grant.
53 oz.	51·4 oz.	49·5 oz.	51 oz.	50 oz.

Hence, in respect of such standards, the brains of Thackeray, De Morgan, Babbage, and Grote show an excess of weight, or a proper weight-variation of 6 oz., 3·1 oz., 3 oz., and 1 oz., respectively; whilst the brain of Professor R. E. Grant was 1·75 oz. below the calculated weight. Such a mode of comparison is of greater interest, and probably of greater value than one with a mean brain weight, determined without reference to differences of stature, such as those of Boyd, Welcker, and some other observers.

I trust, in conclusion, that however imperfect the present investigation may hereafter be shown to be, it will serve to render more complete our knowledge of the quantitative relations, which must assuredly exist between the brain and the body, *i.e.*, between the governing and governed portions of the human frame.