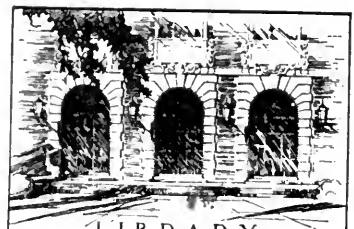

FIELDIANA • ANTHROPOLOGY

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CRANIAL CAPACITIES, A STUDY IN METHODS

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LITERATURE AND TECHNIQUE

Capacity by Experiments and Calculation.—The object of this research is to make a survey of the cranial capacities of various peoples. Consideration will be given to different techniques, and to the compatibility of results obtained by direct measurement and by calculation.

Research in measuring cranial capacities of 429 Melanesian skulls in the Museum collection established several principles that have been previously described (Hambly, 1940, 1946):

(1) Measuring the cranial capacities of a test sample of 50 skulls from New Guinea by the mustard seed method gave an average of 1258 cc. The second average measurement was 1257 cc., and therefore the results are practically identical. I strongly favor the method of weighing the seed and multiplying by a factor to give volume. Pouring the seed into a measuring glass introduces sources of error.

(2) Two students working independently but by the same technique measured the cranial capacities of 47 skulls. The greatest difference for a single skull was 10 cc. The averages were 1267.4 and 1268.8 cc., respectively.

(3) For the 124 skulls of male Melanesians of New Guinea the formula of Isserlis (1914) gives a calculated capacity of 1277, a difference of only 3 cc. from the measured capacity. This formula (Isserlis, 1914, p. 189) reads

$$C = .0003849 \times BLH + 96 \pm 65/\sqrt{N}$$

and it is based on study of 110 male and 81 female skulls from the Gaboon area of west Africa. Since the formula relates to Negro skulls it is not surprising that satisfactory application may be made to the Melanesian skulls of New Guinea, which are Negroid in appearance and have many

average measurements that do not differ significantly from those of African Negroes.

Various Techniques.—We may be satisfied that the mustard seed technique gives consistent results when used by the same worker or by different students following the same procedure; but, unfortunately, comparative study has to deal with different techniques used by different workers and the nature of these variations should be considered.

Martin (1928, vol. 2, pp. 643–648) describes many methods of direct measurement by water, shot, and seed. Stewart (1937) also summarizes such data. The cranial capacities given by Martin (op. cit., pp. 745–746) show variation by sex and race, but he fails to give the number of skulls on which the observations are based, and some of his examples are out of date. It is possible, however, to allow for differences in technique and so make results comparable.

Turner (1884, Zoology, vol. 10, No. 4, pt. 1, p. 9) came to the experimental conclusion that Broca's (1875) method of measuring cranial capacities with shot gave a result about 6.9 per cent higher than that yielded by filling the skull with water or very fine seed; water and fine mustard seed give about the same results in cubic centimeters. My own experiments with a *crâne étalon* showed that fine shot gave a result which is 5.4 per cent too high compared with that given by fine dry mustard seed, and I have therefore used my own figure as a correction. For example, MacCurdy (1914) measured the capacity of eight female skulls of New Britain with shot, which gave a high result of 1214, but if this is reduced by 5.4 per cent a result of 1152 is obtained, and this is compatible with the general trend of capacities for Melanesian females when made by careful measurement. There is no certainty, however, that 5.4 per cent deduction from capacities measured with shot is *always* necessary. If a worker uses the finest bird shot and weighs the shot instead of measuring it in a cylinder, there is a possibility that techniques by shot and seed will give compatible results.

Davis (1867) used fine sand (S.G. 1.425) in his experimental work, and tests made with sand of the same specific gravity in the Museum laboratory indicate that the cranial capacities given with this sand are 8.4 per cent higher than those arrived at by using mustard seed. Davis gave 1432 as the average capacity of nine male skulls from the New Hebrides, and this is obviously high, but a reduction of 8.4 per cent gives 1312, which is reasonably close to 1280 for 124 Melanesian males of New Guinea, and harmonizes with

the general run of measured averages for other male Melanesian groups.

One should emphasize the paucity of measurements that have been made carefully with mustard seed. But fortunately we do have some well-described techniques. Tildesley (1921, p. 177) states that the capacity of Burmese skulls was "taken with mustard seed tightly packed in the skull and then weighed, the worker having previously performed this operation on one of the *crânes étalons*." Wunderly (1939) packed Tasmanian skulls with fine seed that was poured from the skull and measured in a glass cylinder. This method is not so accurate as that of Tildesley. Morant's publication (1927) on Australian and Tasmanian skulls states that "all capacities were accepted, although the different methods used to determine them might well have led to substantially different results." This statement gives us a critical acceptance of the measured capacities, but if we reject them no research is possible. For the European races Morant (1928) states that capacities were obtained by various methods but these were compared and found to be acceptable. Evidently there are different degrees of dependability in our samples; yet we can accumulate enough reliable data to give an accurate idea of the measured capacities by race and sex for a large number of peoples.

One of the most recent contributions to the study of cranial capacities has been made by Simmons (1942). Most of the data were assembled under the direction of the late Professor Wingate Todd. The details of a plastic method are described, whereby the halves of a skull which has been bisected sagittally are filled with removable plastic whose volume can be measured. Professor Todd concluded that the plastic method need produce a measuring error no greater than 10 cc. for a single skull and is therefore more accurate than the water or seed method.

Todd also found that capacities obtained by the seed method tend to surpass capacities obtained by the water method by 80 cc. Capacities obtained by the water method are shown to exceed capacities measured by the plastic method by 15 cc. The article indicates that the technique of the plastic method requires great care. The greatest objection to the method is that it involves bisection of the skull.

Simmons (op. cit., p. 482) gives the average cranial capacities of groups of American White and American Negro skulls obtained by water measurement of large samples. Capacities were 1517 and

1338 for Whites, male and female respectively. These estimates are acceptable and are compatible with a great variety of estimates quoted in this article (pp. 41–45). Todd's experimental determination of capacities of Negro skulls is probably too high. He gives 1467 for Negro males and 1311 for Negro females. Judged by the data assembled in this work (pp. 30–32) the estimates of Todd were about 100 cc. too high. Hrdlička's figure (1928) for full-blooded American Negroes is 1357, which is very close to several measurements of cranial capacities made on African Negro skulls. For American full-blooded Negro females Hrdlička gives a capacity of 1205, which again agrees well with capacities of African Negro skulls, whether measured directly or calculated by formula.

My conclusion is that, although the cranial capacities given by Simmons for American Whites are acceptable, those for American Negroes are not, unless the Negro population of Todd's experiment included a considerable Negro-White mixture. Assumption of a Negro-White mixture in Todd's population would make his estimate of cranial capacities plausible, because his figures of 1467 (male) and 1311 (female) are somewhere between the usual estimates for crania of pure White and pure Negro stock.

Calculated Capacities.—The word "calculated" refers to the application of a formula for determining the average cranial capacity of a group of skulls. The word "measurement" is used throughout the text for the process of filling the skull with seed or other medium, then measuring the cubic contents of the medium so used.

The experiment mentioned (p. 25) shows that a simple arithmetical calculation may give a satisfactory result, that is, one which is almost identical with the figure obtained by the tedious process of direct measurement. But the question is, which formula shall we use? The formula of Isserlis gave an accurate cranial capacity for 124 male skulls of New Guinea, but the general formula of Lee (Lewenz and Pearson, 1904, p. 395) gave a capacity 160 cc. too high in comparison with the measured capacity.

Dr. Hrdlička's suggestion (1925, p. 250) that the cranial module $\frac{L + B + H}{3}$ may give a close approximation to the measured capacity of skulls is an attractive proposition, for its use would be a time-saving device. The table given by Hrdlička compares seven samples of cranial capacities with a view to showing the similarities and disparities resulting from measuring cranial capacities and using the module (mean skull diameter). Some items of

Hrdlička's table indicate that one could have obtained exactly the same result in a fraction of the time by using the cranial module calculation. But selection of other examples from the same table indicates that use of the module instead of experimental measurement of cranial capacity might give a discrepancy of more than 100 cc.

The module method of Hrdlička bears a close resemblance to use of the Manouvrier (1884, see Martin, 1928) formula, $C=LBH/2.4$, for males. Hambly (1940, p. 94) found that this formula gave a capacity of 1279 for 124 male New Guinea skulls. The formula of Isserlis gave for the same sample 1277, and actual measurement with mustard seed gave the capacity as 1280. This possibility of a complete agreement between measured and calculated capacities shows that it is a thankless task to spend many hours in direct measurement if we can get such reliable results by calculation. The data contained in the following tables help a student to judge the chances of calculating average cranial capacities by use of a formula.

The method adopted in the following pages is to apply the unrevised formula of Isserlis to the L, B, H measurements of 114 groups of skulls, 83 male groups and 31 female, of various sizes. Sometimes we have to use the measurement H′ instead of H; usually the difference is a very small one (von Bonin, 1934, p. 11). The table (pp. 30–31) gives measured and calculated capacities, their differences, and the Δ/P_Δ value, which has been explained on page 31. If this value is below 3, one must assume that the difference between the two averages, measured directly and calculated by Isserlis' formula, is possibly due to the nature of our random sampling and is not necessarily significant.

The value of this statistical method should not be overestimated, and our experience of cranial measurements, together with knowledge of the small visual bulk of a cubic centimeter, must aid in judging whether a difference is significant from the practical point of view.

For example, 753 Dynastic Egyptian male skulls (Pearson and Davin, 1924) had a measured capacity of 1439 ± 2.97, and the capacity given by the unrevised formula of Isserlis is 1424.4 ± 2.37. The difference is -15 cc., or one per cent, and most workers would be willing to accept the cranial capacity as 1424 rather than measure 753 skulls by the mustard seed method. But statistically the discrepancy of 15 cc. may be significant, owing to the fact that the series of skulls is a large one and the probable errors of the averages by

NEGRO AND EGYPTIAN MALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_{Δ}
Tanganyika, East Africa (Kitson, 1931)	37	1299.0 ±11.48	1270.0 ±10.70	−29.0 −2.2	1.36*
Kaffirs, South Africa (Kitson, 1931)	21	1422.0 ±24.80	1459.0 ±14.20	+37.0 +2.6	1.28*
Dynastic Egyptians (Pearson and Davin, 1924)	753	1439.0 ±2.79	1424.4 ±2.37	−15.0 −1.0	3.95
Negroes, Congo and Senegal pooled (Aziz, 1929)	50	1336.0 ±19.54	1309.9 ±9.19	−26.1 −1.9	1.21*
Negroes, American full-bloods (Hrdlička, 1928)	36	1357.0 ±11.24	1408.0 ±10.83	+51.0 +3.7	3.30
Wateita, East Africa (Kitson, 1931)	30	1316.0 ±20.72	1296.0 ±11.90	−20.0 −1.5	0.84*
West Africa (Hrdlička, 1928)	7	1360	1350	−10 −0.7	
East Africa, near Nairobi (Hrdlička, 1928)	14	1401	1343	−58 −4.1	
South Africa (Hrdlička, 1928)	6	1402	1421	+19 +1.3	

*Difference not statistically significant.

measurement and calculation are both very small. On the contrary, if the series of skulls is small, the probable error of the average capacity is likely to be a large one, and therefore even a large discrepancy of 50 cc. may be within the range which is not statistically significant for such a small sample.

After completing the table of mathematical comparisons of measured and calculated capacities we can proceed to amend the formula of Isserlis. We must then make application of the formula (revised if necessary) to some further cranial capacities. This must be done to test the validity of the revised formula.

NEGROES AND EGYPTIANS

The tables (pp. 30, 31) make a comparison of average measured capacities with the average capacities derived from the formula of Isserlis. Differences in these capacities are expressed in the upper figures as discrepancies in cubic centimeters, while the lower figures give a percentage difference. Thus for the male skulls of Tanganyika the measured capacity is 1299.0±11.48 cc., and the capacity by formula of Isserlis is 1270.0±10.70 cc. The formula gives a result

NEGRO AND EGYPTIAN FEMALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
Egypt, Dynasties 26–30 (Pearson and Davin, 1924)	472	1301	1289	−12 −0.9	
Egypt, Dynasties 18–21 (Pearson and Davin, 1924)	74	1250	1275	+25 +2.0	
Egypt, Prehistoric Naqada (Pearson and Davin, 1924)	123	1288	1259	−29 −2.2	
South Africa (Hrdlička, 1928)	26	1245	1253	+8 +0.6	
Nairobi region (Hrdlička, 1928)	28	1242	1201	−41 −3.3	
West Africa (Hrdlička, 1928)	6	1182	1172	−10 −0.8	
American full-bloods (Hrdlička, 1928)	19	1205	1205	±0 ±0	
East Africa (Kitson, 1931, from Widemann)	18	1211	1188	−23 −1.9	
Negroes of Egypt (Kitson, 1931)	20	1220	1209	−11 −0.9	
Wateita, East Africa (Kitson, 1931)	33	1192.4 ±8.87	1174.7 ±11.32	−17.7 −1.5	1.23*
Tanganyika (Kitson, 1931)	17	1152.1 ±12.36	1140.7 ±15.76	−11.4 −1.0	0.57*

*Difference not statistically significant.

29.0 cc. (2.2 per cent) lower than that determined by direct measurement. In many instances throughout these tables, Δ/P_Δ values between the measured and calculated capacities have been worked out by application of the well-known formula

$$M_1 - M_2 > 3\sqrt{(PE_1)^2 + (PE_2)^2}.$$

If the difference between the means (M_1 and M_2) is greater than three times the square root of the sum of the square of the probable errors of the two averages, the result may be statistically significant.

In some instances a difference that is not statistically significant is marked with an asterisk. In other instances the reader is left to judge whether he would consider the differences important. The working out of probable errors for all samples is a formidable task; but enough have been calculated to show the general nature of errors calculated from samples of various sizes.

The conclusions derived from these tables are:

(1) That the formula of Isserlis somewhat unexpectedly gives for Egyptian skulls a result close to the measured capacity of a large sample. For male skulls the difference is 15 cc. (one per cent), for females −29 to +25 cc. For both sexes the formula gives a little less than the actual measurement.

(2) The crude average measured capacity of Negro male skulls is about 1346 cc. The largest sample of female Negro skulls has an average capacity of 1192 cc.

(3) Ranges of average cranial capacities of Negroes are as follows:

	By measurement	By calculation
*Males	Max. 1422.0±24.80 South Africa Min. 1299.0±11.48 East Africa	Max. 1459.0±14.20 South Africa Min. 1270.0±10.70 East Africa
†Females	Max. 1245 South Africa Min. 1182 West Africa	Max. 1253 South Africa Min. 1172 West Africa

*Results close by measurement and formula.

†Very small discrepancy between measured and calculated capacities.

MELANESIANS

The suitability of the formula of Isserlis for calculating the capacity of Melanesian skulls is demonstrated in the attached tables (pp. 33–35). A large series of measurements indicates that the crude average capacity for males is about 1323 and for females 1192, and application of the unamended Isserlis formula gave 1317 and 1190 for the same data. There is a negligible divergence between the measured and the calculated capacities.

We can therefore use the measured capacities of 1323 and 1192 as standards by which to judge the applicability of the Isserlis formula to a series of male and female skulls from New Ireland. The measurements on these skulls were made by Dr. O. Schlaginhaufen, who kindly permitted their use. His full data have not yet been published.

For a series of 238 male skulls the average L, B, and H′ dimensions are 181.2, 130.2, and 134.6, respectively, and these measurements when used in the Isserlis formula give a cranial capacity of 1318, which is very close to our general Melanesian measured standard of 1323. Martin (1928, p. 746) gives Schlaginhaufen's measurement by seed as 1347 for males.

The data of Schlaginhaufen include also three groups of female skulls from Ambitlé (38), Babase (95), and Tatau (47), all of which,

MELANESIAN MALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_{Δ}
New Guinea (Hambly, 1940)	120	1280.0 ±6.06	1277.0 ±5.84	−3.0 −0.20	1.36*
New Guinea (Wirz, 1926)	98	1345.0 ±7.20	1275.9 ±6.56	−69.1 −5.1	7.10
New Guinea (Graf, 1931)	15	1308.0 ±19.80	1281.2 ±16.80	−26.8 −2.0	1.0*
New Guinea (Broek, 1923a)	43	1250.0 ±11.70	1245.0 ±6.50	−5.0 −0.04	0.04*
New Guinea (Bondy-Horowitz, 1930)	34	1317.0 ±11.57	1314.0 ±11.14	−2.6 −0.2	0.16*
New Guinea, D'Entrecasteaux Islands (Sergi, 1892–93)	65	1294.0 ±9.50	1286.1 ±8.06	−7.9 −0.6	0.63*
New Guinea, Kaniet Island (Hambruch, 1906)	18	1342.0 ±11.47	1290.0 ±15.32	−52.0 −3.9	2.7*
New Guinea, Woodlark Island (Sergi, 1892–93)	18	1394.0 ±18.08	1387.0 ±15.32	−7.0 −0.5	0.3*
Fiji (Krause, 1881)	21	1406.0 ±15.98	1499.0 ±14.18	+93.0 +6.6	4.3
Fiji (Flower, 1880)	8	1496.0 ±21.65	1482.0 ±22.98	−14.0 −0.9	0.4*
Fiji (Krause, 1881)	35	1372.0 ±12.95	1438.0 ±10.98	+66.0 +4.8	3.9
Loyalty Islands (Quatrefages and Hamy, 1882)	18	1460.0 ±18.06	1431.0 ±15.30	−29.0 −2.0	1.2*
Loyalty Islands (Sarasin, 1916–22)	34	1463.0 ±13.12	1439.0 ±11.15	−24.0 −1.6	1.4*
Ambrym (Hambly, 1946)	20	1318.7 ±15.46	1301.7 ±14.53	−17.0 −1.3	0.80*
New Hebrides (Krause, 1881)	10	1310.0 ±24.31	1371.0 ±20.50	+61.0 +4.6	1.9*
New Hebrides (Davis, 1867)	9	1311.7 ±21.73	1347.0 ±21.66	+35.3 +2.7	1.15*
Malekula (Hambly, unpublished)	33†	1298.5 ±9.35	1242.4 ±11.31	−56.1 −4.3	3.80
New Caledonia (Sarasin, 1916–22)	89	1420.0 ±8.10	1402.0 ±6.60	−18.0 −1.3	1.7*

*Difference not statistically significant.

†Deformed.

MELANESIAN MALES—*Continued*

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
New Caledonia (Hambly, unpublished)	13	1385.5 ±12.61	1365.3 ±18.03	−20.2 −1.4	0.91*
New Caledonia (Aziz, 1929)	50	1344.0 ±9.54	1338.1 ±9.19	−5.9 −0.4	0.44*
New Britain, Baining tribe (Bauer, 1915)	43	1242.9 ±10.28	1305.6 ±9.91	+62.7 +5.0	4.40
New Britain (Hrdlička, 1928)	13	1312.0 ±23.51	1363.4 ±18.03	+51.4 +3.9	3.90
Solomon Islands (Frizzi, 1913)	26	1274.0 ±14.97	1284.4 ±12.74	+10.4 +0.8	0.52*
Solomon Islands, Santa Cruz (Speiser, 1923a)	26	1338.0 ±13.23	1312.9 ±12.74	−25.1 −1.9	0.88*
Solomon Islands (Hrdlička, 1928)	5	1403.0 ±11.53	1368.0 ±29.09	−35.0 −2.5	1.1*
New Ireland (Hambly, unpublished)	13	1302.0 ±22.26	1293.9 ±18.03	−8.1 −0.6	0.28*

MELANESIAN FEMALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
New Guinea (Hambly, 1940)	70	1153.0 ±6.08	1161.0 ±5.24	+8.0 +0.7	1.0*
New Guinea (Wirz, 1926)	49	1233.0 ±7.28	1212.0 ±8.53	−21.0 −1.7	1.9*
New Guinea (Bondy-Horowitz, 1930)	12	1127.9 ±19.24	1126.8 ±18.76	−1.1 −0.1	0.04*
New Guinea, Woodlark Island (Sergi, 1892–93)	30	1143.0 ±9.30	1127.0 ±11.86	−16.0 −1.4	1.06*
New Britain (MacCurdy, 1914)	8	1152.1 ±23.53	1170.0 ±22.98	+17.9 +1.5	0.5*
New Britain, Duke of York Island (Krause, 1881)	28	1189.0 ±9.62	1283.3 ±12.28	+94.3 +7.9	6.05
Solomon Islands (Frizzi, 1912–13)	13	1147.0 ±18.46	1217.4 ±18.0	+70.4 +6.1	2.73*
Solomon Islands, Santa Cruz (Speiser, 1923a)	24	1233.0 ±10.34	1168.0 ±13.27	−65.0 −5.3	3.9

*Difference not statistically significant.

[Note to Librarians]

FIELDIANA

In December 1943, the name of Field Museum of Natural History was changed to Chicago Natural History Museum. Since that time it has not been practical to make the called-for change in the name of the Museum's technical publications. Beginning in 1945, these publications of the Museum will appear under the general title of Fieldiana, *with division as formerly into five series—Anthropology, Botany, Geology, Zoology, and Technique. These series will be continuous with the volumes already published and will carry their successive numerical designations as if no change of name had been made. The name "Fieldiana" will appear only in connection with these series and all other publications of the Museum will carry other titles.*

The correct citation for the publications in the Fieldiana *octavo series will be Fieldiana, followed by the name of the series to which the publication belongs, and its volume number, etc.; for example, Fieldiana, Zoology, vol. 00, no. 0, pp. 00–00. For the Memoirs (quarto size) the citation should be Fieldiana, Anthropology Memoirs, vol. 00, no. 00, pp. 00–00.*

The new name will not be used for the concluding parts of volumes now partly published nor for additions to sets devoted to a single subject, as, for example, the Flora of Peru. *These volumes and sets will be completed as soon as possible but will continue to bear the serial designation with which they started and the former name of the institution.*

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that the Isserlis formula was calculated from measurements on Negro skulls, which have a flat frontal region, whereas the Australian skulls have a heavy supraciliary ridge. This ridge is part of the maximum skull length, but its thickness of perhaps 8 mm. adds nothing to the internal capacity. This suggestion is to some extent supported by the fact that the Isserlis formula gives more acceptable results for Australian females than for males. The brow-ridge is less developed in females than in males, and there is therefore not so much bony prominence to add to the length of the skull without increasing the internal capacity.

The formula of Dr. von Bonin (1934, p. 14), which was worked out for male skulls of New Britain, and these are Australoid in appearance, might serve to calculate the capacities for series of Australian skulls whose cranial content is unknown. The formula of von Bonin reads

$$C = .000263 \times BLH' + 404.9 \pm 35.1/\sqrt{N.}$$

The following table gives the capacities calculated by the two different formulae and shows the divergence of the results from the measured capacity.

AUSTRALIAN SKULLS

Source	Number of skulls	Capacity by von Bonin's formula	Divergence from measured mean, in cc. and percentage	Capacity by Isserlis' formula	Divergence from measured mean, in cc. and percentage
Robertson (1910–11).....	78 ♂	1232	−62 −4.8	1306	+12 +0.9
Robertson (1910–11).....	22 ♀	1145	−2 −0.2	1179	+32 +2.8
Hrdlička (1928).....	505 ♂	1283	−11 −0.8	1381	+87 +6.7
Hrdlička (1928).....	395 ♀	1172	+25 +2.2	1122	−25 −2.2

The table indicates that the formula of von Bonin is to be preferred to that of Isserlis for calculating the cranial capacities of Australian skulls.

When the two formulae are applied to cranial measurements of male skulls, supplied by Hrdlička (1928) from five regions of Australia, the following results are obtained (p. 37, top). The samples are satisfactory in size.

AUSTRALIAN MALES

Region	Number of skulls	Capacity by von Bonin's formula	Divergence from measured mean, in cc. and percentage	Capacity by Isserlis' formula	Divergence from measured mean, in cc. and percentage
South Australia	194	1278	−16 −1.2	1374	+80 +6.2
Northern territory	102	1256	−38 −2.9	1341	+47 +3.6
Victoria	73	1327	+33 +2.5	1446	+152 +11.7
New South Wales	57	1297	+3 +0.2	1402	+108 +8.3
Queensland	49	1283	−11 −0.8	1381	+87 +6.7
Crude average	475	1288	−6 −0.5	1389	+95 +7.3

The figures show that for male Australian skulls the formula of Isserlis gives capacities that are too high, that they are consistently so, and that they would give an approximate error of 7.3 per cent above the expected measured value.

AUSTRALIAN MALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
Morant (1927)	146	1294.6 ±6.68	1368.0 ±5.38	+73.4 +5.6	8.5
Wagner (1937)	98	1294.0 ±10.28	1253.0 ±6.57	−41.0 −3.2	3.3

AUSTRALIAN FEMALES

Morant (1927)	67	1147.4 ±6.60	1176.8 ±7.94	+29.4 +2.6	2.8*
Wagner (1937)	11	1103.4 ±16.28	1173.3 ±19.60	+69.9 +6.3	2.7*

*Difference not statistically significant.

On the contrary, the formula of von Bonin gives results that are all fairly compatible with the general measured mean of 1294.

For a large group of female skulls (395) pooled by Hrdlička for L, B, H measurements, the formula of von Bonin gave a capacity of 1172. This is by no means unacceptable by comparison with the measured standard of 1147, which is that of Morant (1927) based on measurements of 67 skulls. The formula of Isserlis, though generally unacceptable for male skulls, gives for female skulls results by no

means unlikely, namely, 1122 for Hrdlička's sample and 1179 for Robertson's sample.

On the whole, I think that either von Bonin's or Isserlis' formula will give a reasonable approximation to the cranial capacity of *female* Australian skulls, and without making changes in the formulae; but for calculating the capacity of male Australian skulls the formula of von Bonin is preferable to that of Isserlis and may be used without amendment.

TASMANIAN MALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
Tasmania (Wunderly, 1939)	14	1247.1 ±20.48	1376.1 ±17.37	+129 +10.3	4.8
Tasmania (Morant, 1927)	33	1264.3 ±13.34	1344.5 ±11.32	+80.2 +6.4	4.6

TASMANIAN FEMALES

Tasmania (Morant, 1927)	25	1153.8 ±10.18	1210.8 ±13.00	+57.0 +4.9	3.4
Tasmania (Wunderly, 1939)	14	1242.8 ±13.61	1297.4 ±17.37	+54.6 +4.4	2.4*

*Difference not statistically significant.

These averages of cranial capacities of Tasmanians are based on small samples, and according to this slender evidence the capacity for males is about 1264 and that for females approximately 1153. Morant's data are based on numbers almost twice as large as those of Wunderly. These are measured capacities that are used as standards of comparison for the calculated capacities given in the following table.

TASMANIAN SKULLS

Source	Number of skulls	Capacity by formula of Isserlis	Divergence from measured capacity in cc. and percentage	Capacity by formula of von Bonin	Divergence from measured capacity in cc. and percentage
Robertson (1910–11)	54 ♂	1371	+107 +8.5	1276*	+12 +0.9
Hrdlička (1928)	22 ♂	1457	+193 +15.3	1334	+70 +5.5
Robertson (1910–11)	30 ♀	1229	+76 +6.6	1179*	+26 +2.2
Hrdlička (1928)	15 ♀	1235	+82 +7.1	1182*	+29 +2.5

*Acceptable result.

The data given in the three tables on page 38 clearly indicate that the Isserlis formula gives capacities that are too high, as it did for Australian skulls. The lower table shows the approximation to measured capacities given by the formula of Isserlis, and also by that of von Bonin, both without amendment. The L, B, H measurements are provided by Hrdlička and by Robertson, but these investigators did not measure cranial capacities.

Only three results, namely, those marked with an asterisk, and all of them from application of von Bonin's New Britain formula, are acceptable. The details of inquiry confirm the opinion emphasized on page 35.

POLYNESIANS

The following tables make a comparison of the measured and calculated capacities of several groups of Polynesian male and female skulls.

POLYNESIAN MALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
Sandwich Islands (Hawaii)..... (Wagner, 1937)	56	1456.0 ±13.37	1515.0 ±8.69	+59.0 +3.4	3.1
Hawaii..... (Hambly, unpublished)	16	1437.8 ±17.23	1462.7 ±16.25	+24.9 +1.7	1.0*
Marquesas Islands..... (Wagner, 1937)	19	1475.0 ±31.11	1473.0 ±14.91	−2.0 −0.1	0.06*
Tonga and Samoa..... (Krause, 1881)	9	1460.0 ±27.88	1519.0 ±18.76	+59.0 +4.0	1.7*
Easter Island..... (von Bonin, 1931b)	36	1462.0 ±12.76	1493.0 ±10.83	+31.0 +2.1	1.85*
Moriori..... (Thomson, 1915–17)	57	1438.8 ±8.93	1479.3 ±8.61	+40.5 +2.8	3.30
Moriori..... (Scott, 1894)	29	1454.9 ±12.52	1481.4 ±14.18	+26.5 +1.8	1.40*
Maori, North Island..... (Weisbach, 1890)	13	1405.0 ±5.99	1440.8 ±18.03	+35.8 +2.5	1.48*
Maori..... (von Luschan, 1907)	40	1450.5 ±10.66	1470.0 ±10.27	+19.5 +1.3	1.32*
Maori..... (Scott, 1894)	45	1476.0 ±10.06	1467.5 ±9.68	−8.5 −0.6	0.61*
Maori..... (Wagner, 1937)	35	1435.0 ±11.40	1450.0 ±11.00	+15.0 +1.0	0.95*

*Difference not statistically significant.

POLYNESIAN FEMALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
Maori (Wagner, 1937)	21	1362.9 ±16.04	1350.2 ±14.18	−12.7 −0.9	0.59*
Maori (von Luschan, 1907)	32	1307.5 ±13.00	1290.5 ±11.49	−17.0 −1.3	0.98*
Moriori (Thomson, 1915–17)	28	1304.5 ±13.89	1327.2 ±12.28	+22.7 +1.7	1.2*
Sandwich Islands (Hawaii) (Wagner, 1937)	45	1324.6 ±8.73	1345.2 ±9.68	+20.6 +1.5	1.57*
Polynesians, pooled (Hambly, unpublished)	136	1320.0 ±5.32	1328.5 ±5.57	+8.5 +0.6	1.10*

*Difference not statistically significant.

The formula of Isserlis gives for Polynesian male crania a result 1.8 per cent too high, and for female crania 0.4 per cent too high. The crude average capacity for males by measurement is 1451 cc. and the calculated capacity is 1477 cc. For female crania the measured and calculated capacities are closer. The crude average for females is 1324 measured and 1328 by formula. The results for female Polynesian skulls support the previous suggestion (p. 36) made for Australian skulls. The formula of Isserlis was worked out for Negro skulls with flat foreheads (a female trait); therefore the formula gives more acceptable results for *females* of other racial groups.

POLYNESIAN MALES

Source	Number of skulls	Calculated capacity by Isserlis' formula	Divergence from Polynesian general measured mean (1451 cc.) in cc.
Marquesas Islands (von Luschan, 1907)	16	1462 1436	+11 −15
Maori (Morant, unpublished)	74	1451 1425	±0 −26
Maori, North Island (Morant, unpublished)	42	1491 1464	+40 +13
Maori, pooled (von Bonin, unpublished)	115	1469 1443	+18 −8
Polynesians, pooled (von Bonin, unpublished)	157	1467 1441	+16 −10
Loyalty Islands, Lifou (Bertillon, 1872)	10	1454 1428	+3 −23

The foregoing table (p. 40) gives a comparison of cranial capacities. The upper of the bracketed figures are the results obtained by using the unchanged formula of Isserlis, and the lower figures are those obtained by reducing the result by 1.8 per cent (*vide supra*). Unfortunately there are no capacities by direct measurement for these groups of skulls. The table (p. 40) indicates that 1451 cc. is the crude average capacity for Polynesian male skulls, and if this is accepted then the calculated results by Isserlis' formula either amended or unchanged give plausible results. For Morant's 74 Maori skulls the unchanged formula gives a capacity of 1451 cc., and 1425 if 1.8 per cent is deducted. Acceptance of either of these capacities would be preferable to measuring the capacity of 74 skulls by the slow mustard seed technique. Other calculated results come close to the general mean (1451 cc.), and perhaps most craniometrists would be willing to accept them instead of actually measuring the capacities.

EUROPEANS

Old English.—The following tables (pp. 41–43) indicate that if the formula of Isserlis is used to work out the capacity of Old English skulls the result is likely to be 2.1 per cent too low. Therefore, when making estimates of the capacity of Old English skulls we must add 2.1 per cent to any result given by the original formula of Isserlis.

Morant (1926) calculated some capacities by Hooke's (1926) formula

$$C = .000366 \times LBH + 198.9$$

and found the results given in the table below, upper series of figures:

Formula	English and Scottish Neolithic	English Bronze Age	Scottish Bronze Age	English and Scottish Iron Age	Anglo-Saxon
Hooke.....	1533	1564	1561	1488	1543
Isserlis + 2.1%....	1530	1564	1561	1481	1542

Since Hooke's formula is based on measurements of English skulls we may assume that the capacities which Morant gives (upper series) are correct, for his samples are all English and Scottish skulls, and the application of Hooke's formula for finding their capacities was therefore appropriate.

The lower line of figures, which make a very close fit with the upper, indicates that, had there been no formula specially applicable to Morant's data, the formula of Isserlis + 2.1 per cent would have given dependable results.

OLD ENGLISH MALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_{Δ}
Farringdon Street (Hooke, 1926)	86	1481.5 ±9.46	1438.1 ±7.01	−43.4 −2.9	3.68
Whitechapel (Hooke, 1926)	72	1476.9 ±9.73	1438.1 ±7.66	−38.8 −2.6	3.14
Moorfields (Hooke, 1926)	22	1473.8 ±19.01	1447.7 ±13.85	−26.1 −1.8	1.11*
Hythe (Stoessiger and Morant, 1932)	110	1456.3 ±7.00	1443.0 ±6.19	−13.3 −0.9	1.4*

*Difference not statistically significant.

OLD ENGLISH FEMALES

Farringdon Street (Hooke, 1926)	132	1296.5 ±6.12	1257.9 ±5.6	−38.6 −2.9	4.6
Whitechapel (Hooke, 1926)	80	1299.9 ±8.51	1261.4 ±7.27	−38.5 −2.9	3.4
Moorfields (Hooke, 1926)	31	1365.3 ±13.68	1296.6 ±11.67	−68.7 −5.0	3.8
Hythe (Stoessiger and Morant, 1932)	83	1318.0 ±7.30	1279.0 ±7.13	−39.0 −2.9	3.8

Irish Skulls.—Howells (1941) does not give the cranial capacities of 120 male skulls from Gallen Priory, but he supplies the average L, B, and H′ measurements. These dimensions, when used in the formula of Isserlis, give a cranial capacity of 1530, and the addition of 2.1 per cent brings the capacity up to 1562. This is somewhat high compared with the crude general mean of 1472 for Old English male skulls and 1488 for European male skulls. But the Irish skulls are long and broad, and the dimensions suggest that the capacity will be a high one.

Perhaps one ought not to apply anything English to the solution of an Irish problem, but, according to Hooke's formula, which was prepared from measurements on English skulls, the capacity of the Irish skulls should be 1563. This is only one cubic centimeter greater than the cranial capacity (1562) obtained by the revised formula of Isserlis.

Scottish Skulls.—Data relating to cranial capacities of Scottish skulls are based on a study of a modern collection of 700 specimens (Young, 1916, 1931). But no cranial capacities of these Scottish

EUROPEAN MALES

Ancient and Modern

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
(Morant, 1923)					
Serbo-Croats	79	1524.6 ±8.61	1454.3 ±7.31	−70.3 −4.6	6.2
Greeks	86	1489.0 ±8.25	1418.3 ±7.01	−70.7 −4.7	6.5
Turks	39	1457.1 ±12.26	1435.2 ±10.41	−21.9 −1.5	1.4*
Slovenes	48	1406.2 ±11.05	1414.5 ±9.38	+8.3 +0.6	0.6*
Rumanians	38	1478.9 ±12.42	1413.6 ±10.54	−65.3 −4.0	4.0
Czechs	108	1438.4 ±7.36	1391.2 ±6.25	−47.2 −3.3	4.9
Swiss, Valais	159	1542.7 ±6.08	1468.6 ±5.15	−74.1 −4.8	9.3
Swiss, Sierre	28	1547.1 ±14.47	1502.6 ±12.28	−44.5 −2.9	2.3*
Württemberger	91	1493.8 ±8.03	1423.4 ±6.81	−70.4 −4.7	6.7
Badensians	78	1524.9 ±8.67	1473.1 ±7.36	−51.8 −3.4	4.6
French	56	1473.1 ±10.23	1396.0 ±8.69	−77.1 −5.2	5.7
Guanche	76	1503.9 ±8.78	1444.2 ±7.45	−59.7 −4.0	5.6
Etruscans	78	1456.0 ±8.67	1446.2 ±7.36	−9.8 −0.7	0.9*
Pompeians	51	1503.6 ±10.72	1404.7 ±9.10	−98.9 −6.6	7.0

*Difference not statistically significant.

skulls have been measured by mustard seed. Nevertheless, the following table gives a fair indication of the approximate capacity judged by (1) measurements with shot (No. 8B), (2) calculations of capacity by the formula of Hooke for English skulls, and (3) by the formula of Isserlis for the Negro skull +2.1 per cent. This is the addition we agreed to allow after testing that formula against the carefully measured capacity of several groups of English skulls (p. 41).

Method	Males	Females
By shot (No. 8B)	1526 1511 1478	1322 1314 1300
By Hooke formula	1473	1315
By Isserlis formula + 2.1%	1465	1315

There is fairly good agreement in the three methods of determining the capacity. The three quotations for measurement by shot relate to results obtained by division of the collection. Two of the measurements by shot seem somewhat high, but according to our experiment (p. 26) a reduction of 5.4 per cent is permissible in order to make shot measurements comparable with those arrived at by using mustard seed.

For female measurements there is identity of result (1315 cc.) arrived at by the formulae of Hooke and of Isserlis (amended), and these calculated results are in harmony with the three capacities (1300–1322) measured with shot.

The figure of 1322 (shot) for female Scottish skulls is high compared with capacities measured with mustard seed for four groups of female English skulls (p. 42). A crude average for the English females is 1274, and reduction of 1322 (shot) by 5.4 per cent gives 1251 for Scottish skulls, which is close to the English capacity.

According to the collated data of Martin the crude average for European females is 1296, which is quite close to the Scottish value of 1300–1322 by shot. We have also pointed out that a value of 1315 for female Scottish skulls is given by two independent formulae, and one feels dubious about reducing the shot measurement in this particular instance.

Turner (see p. 26, this work) himself, who is responsible for the measurements of these Scottish skulls by shot, thought that 6.9 per cent should be deducted, which is rather more than my own experiments would allow. But my suggestion is that he used such fine shot (No. 8B), and furthermore that he packed the skulls and then the measuring cylinder so carefully, that he has obtained in this particular instance a result very close to that which would have been obtained by using water or very fine seed.

In the textbook of Rudolf Martin (1928, p. 745) average capacities are given for fifteen geographical groups of European skulls. All these capacities were measured by shot, and they yield a crude average of 1543 for males and 1370 for females. If this result is

reduced by 5.4 per cent (p. 26, this work) the average capacities for European males become 1460 and for females 1296.

Martin then gives (op. cit., p. 746) a list of European cranial capacities for 13 male and 12 female geographical groups, all of which were found by measurement with water or mustard seed. The crude average capacities are 1447 for males and 1296 for females. Comparison of the capacities collated by Martin suggests that my deduction of 5.4 per cent from capacities calculated by use of shot is experimentally sound, for we have from Martin's collated data:

Capacity by shot (reduced 5.4%)	Capacity by seed or water	Differences in cc.
1460 (♂)	1447 (♂)	−13
1296 (♀)	1296 (♀)	±0

SOUTH AMERICAN INDIANS

The following table (p. 46) has been compiled from data kindly supplied by Dr. T. D. Stewart and Dr. Marshall T. Newman. From these figures I have calculated a general weighted average cranial capacity for 513 South American Indian males and for 226 females. The average capacity of the male skulls is 1442.96 ± 3 cc. and for the females, 1315.70 ± 4.43 cc. The cranial content of the average male skull is about 8.8 per cent in excess of that of the average female skull, a result compatible with the data tabulated. The table of sex differences in cranial capacities (p. 62) shows a percentage difference of 13.1 for Australian skulls. This is a maximum excess of male over female cranial capacity. The smallest excess of male over female cranial content is 4.6 per cent for Tasmanian skulls.

The average cranial capacity for South American Indian male skulls (1442.96) is close to the capacities for skulls of North American Indians and Eskimo (p. 47). The capacity for female crania of South America (1315.70) fits very well with the capacities of some groups of females of North American Indian tribes (p. 48).

The variability of cranial capacities in the groups of South American Indians may be judged to some extent by the standard deviations given by Dr. T. D. Stewart. For males, the ranges of the standard deviations are 142.85 (72 Calchaqui) to 99.68 (45 Parana Delta Indians). The standard deviation for cranial capacity of 753 Egyptian males is 113.51 ± 1.97 (Pearson and Davin, 1924) and the interracial standard deviation for male cranial capacity is 100.2 ± 2.53 (Hambly, 1946, p. 115). The high standard

deviation of 142.85 for 72 Calchaqui Indians may represent a wide scatter of values in the array of measurements. But it is also true that any careless filling of the skull or failure to tamp the seed in the measuring glass will lead to a very wide range of measurements in the results.

The standard deviations for measurements of cranial capacities in female skulls for South American Indians range from 128.25 to 92.26. The latter is normal; the former is high. For 472 Egyptian female skulls the standard deviation of the cranial capacities is 98.68 ± 14.19. This figure is close to the standard deviations of that trait for South American Indian skulls, which for the several groups are 111.90 ± 7.47, 112.45, 112.22, 117.85. On the whole, the cranial capacities of the South American Indian skulls show a normal variability.

SOUTH AMERICAN SKULLS

By courtesy of Dr. T. Dale Stewart and Dr. M. T. Newman

Tribe	Number of skulls		Mean cranial capacities	
	Males	Females	Males	Females
Rio Negro Patagonians..... (Marelli, A. 1913)	76	51	1452.10± 9.48	1356.56±10.57
Rio Chobut Patagonians.... (Marelli, A. 1913)	41	29	1531.58±13.28	1359.68±16.04
Calchaqui..... (Kunike, H. 1911)	72	44	1417.06±11.35	1247.86±11.44
Calchaqui..... (Constanzo, M. 1942)	70	30	1466.14±10.40	1339.00±11.36
Ona..... (Gusinde, M. 1939)	22	8	1426.25±16.14	1355.62
Yahgan..... (Gusinde, M. 1939)	33	19	1435.74±13.37	1289.63
Paucarcancha..... (MacCurdy, G. G. 1923)	108	..	1371.92± 6.95	.....
Botocudo*..... (Ehrenreich, P. 1887)	32	..	1431.81±13.58	.....
Parana Delta..... (Torres, L. M. 1911)	45	19	1529.72±10.03	1343.16
Cucurital..... (Marcano, G. 1893)	14	26	1488.71	1328.85± 8.65

*For further measurements see bibliography of T. D. Stewart, 1943, pp. 268, 269.

NORTH AMERICAN INDIAN AND ESKIMO

The method of comparing the measured and calculated capacities of North American crania is the same as that used in previous chapters.

The following table shows a close fit between measured and calculated capacities of North American crania. For five groups of data out of six, the differences between the capacities so obtained are not significant. On the average the formula of Isserlis gives a result which is 1.4 per cent too low.

NORTH AMERICAN INDIAN AND ESKIMO MALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
North American Indians, Kentucky (von Bonin and Morant, 1938)	24	1432.5 ±15.63	1386.6 ±13.26	−45.9 −3.2	2.2*
North American Indians, Cheyenne, Chippewa, Piegan, pooled (von Bonin and Morant, 1938)	41	1514.0 ±11.96	1456.7 ±10.15	−57.3 −3.8	3.6
North American Indians, East-Central, pooled (von Bonin and Morant, 1938)	33	1500.0 ±13.33	1495.0 ±11.32	−5.0 −0.3	0.3*
North American Indians, Ohio, Indiana, Michigan, Illinois, pooled (von Bonin and Morant, 1938)	25	1490.6 ±15.31	1480.6 ±13.00	−10.0 −0.7	0.5*
North American Indians, California (von Bonin and Morant, 1938)	128	1349.1 ±6.58	1350.1 ±5.74	+1.00 +0.07	0.11*
Eskimo (Morant, 1937)	200	1473.1 ±5.41	1470.0 ±4.59	−3.1 −0.2	0.44*

*Difference not statistically significant.

A further test of the applicability of the Isserlis formula for calculating the capacity of male Eskimo skulls is made in the table on page 48. The *measured* capacities are given by Morant (1937) from various sources which he quotes in detail.

Out of six applications of the formula three give results which, judging by the measured capacities, have errors of less than one per cent. Agreement of actual measurement and of calculation are not satisfactory in the two instances marked with a double dagger. It is difficult to understand why the Isserlis formula should give a discrepancy of only 0.2 per cent for 200 Western Eskimo skulls, and

ESKIMO MALES

Source	Number of skulls	Measured capacity	Capacity by unrevised Isserlis formula	Differences in cc. and percentage
†Greenland	217	1526	1451	−75‡ −4.9
Northwestern	45	1435	1466	+31 +2.2
Central	17	1558	1516	−42‡ −2.7
Nunivak Island	46	1504	1492	−12 −0.8
Point Hope	126	1474	1460	−14 −0.9
Western	200	1473	1470	−3 −0.2
Crude averages	651	1495	1476	−19 −1.3

†Pooled value from data of Fürst and Hansen (1915) and Hrdlička (1924). The other data are from Hrdlička (1924).

‡Agreement of actual measurement and of calculation are not satisfactory.

a discrepancy of 4.9 per cent for a group of 217 Greenland skulls. One can readily understand that the measured and calculated capacities for *small* groups of skulls might be at variance, for example in the case of only 17 Central Eskimo skulls, but usually compatibility of the calculated with the measured capacity increases with the size of the group. This is likely to be so because a small group of skulls may be dominated by a few examples of exceptional shape or size. The general conclusion is that if we take a crude average for 651 male Eskimo skulls the measured capacity is 1495 and the calculated capacity is roughly 1476, so giving a discrepancy of −1.3 per cent.

Some measured cranial capacities recorded by Hrdlička for female American Indian skulls enable us to test the usefulness of a *revised* Isserlis formula.

Hrdlička gives the following measured capacities (upper figures) and below these are the capacities obtained by using the formula of Isserlis and adding 1.4 per cent to the result.

	Algonkin & Iroquois (6)	New York State (9)	Kentucky (21)	Illinois (21)	Siouan (13)	Pueblos (43)	Crude average (113)
Measured	1349	1331	1280	1305	1334	1166	1294
Calculated	1343	1319	1240	1322	1302	1169	1282

If Hrdlička had not measured these skulls of female Indians, and we had used the formula of Isserlis (+1.4 per cent), we should have had results comparing very closely with capacities which were actually measured. The crude average capacity by measurement is 1294, and since the calculated capacity found by revised formula of Isserlis is 1282, there is a discrepancy of only 0.9 per cent.

The revised formula of Isserlis gives satisfactory results when applied to groups of female Indian skulls, with the possible exception of the Kentucky group, for which there is a discrepancy of 3.1 per cent between the measured and the calculated capacities. However, the formula is not necessarily inaccurate. Errors in actual measurement are always possible, and the formula may be giving the more accurate result.

ESKIMO SKULLS

From the data supplied by Stewart (1939) we can calculate the cranial capacities of groups of male and female Eskimo skulls for which he gives average L, B, and H′ measurements. Since Stewart did not actually measure the cranial capacities, we must use Morant's (1937) measured average of 1473 for 200 pooled male Eskimo skulls. This is a standard by which we can judge the accuracy of results given by the formula of Isserlis when used on Stewart's data.

FORMULA OF ISSERLIS APPLIED TO STEWART'S DATA

	Labrador	Thule	Greenland	Old Igloo
	(38)	(21)	(49)	(30)
Males	1418	1485	1482	1480
	(37)	(10)	(52)	(31)
Females	1247	1379	1249	1283

The result given by the Isserlis formula when applied to male Labrador skulls is somewhat low according to Morant's general figure of a measured 1473 for pooled Eskimo. But the capacities for males of Thule, Greenland, and Old Igloo, arrived at by the unrevised formula of Isserlis, are very close to Morant's standard.

We have no data for judging how accurate the formula of Isserlis has been in our calculation of the capacities of female Eskimo skulls, but probably the capacities are approximately correct, since they are on the average 12.1 per cent lower than the capacities of the male skulls (see table, p. 62).

ASIATICS

For the study of cranial capacities of Asiatic peoples we have three principal summaries: Morant (1924), von Bonin (1931a), and

Woo and Morant (1932). The bibliographies given by these writers are extensive and their items are critically examined. The most important bibliographical items are quoted in my own bibliography at the end of this work. Morant has placed in square brackets the cranial capacities obtained by what he calls "doubtful methods," and in the three compilations just quoted the respective authors acknowledge the hazards attending paucity of data and the pooling of results obtained by different workers. Yet, despite objections, the data give some acceptable cranial capacities for a large number of Asiatic peoples whose geographical location is given in a series of maps (von Bonin, 1931a) and in a general map by Woo and Morant (1932, p. 110).

As a preliminary study I have collated in the following table a series of measurements of cranial capacities which appear to have been carefully made by the use of mustard seed, though the technique is variable.

ASIATIC MALES

Source	Number of skulls	Measured capacity	Capacity by formula of Isserlis	Differences in cc. and percentage	Δ/P_Δ
Mongols (Woo and Morant, 1932)	112	1573.0 ±7.23	1488.6 ±6.14	−84.4 −5.4	8.9
Japanese (von Bonin, 1931a)	129	1474.8 ±6.74	1460.6 ±5.72	−14.2 −1.0	1.6*
Chinese (Morant, 1924)	46	1467.6 ±11.29	1397.8 ±9.58	−69.8 −4.7	4.7
Tibetan B (Morant, 1924)	14	1537.7 ±20.46	1430.7 ±17.37	−107.0 −6.9	4.0
Tibetan A (Morant, 1924)	36	1452.4 ±12.76	1323.8 ±10.83	−128.6 −8.8	7.7
Nepalese (Morant, 1924)	47	1436.2 ±11.17	1295.1 ±9.48	−141.1 −9.8	9.6
Malayan (Morant, 1924)	76	1424.4 ±8.78	1409.8 ±7.45	−14.6 −1.0	1.3*
Burmese A (Tildesley, 1921)	27	1406.9 ±14.73	1401.1 ±12.51	−5.8 −0.4	0.3*
Philippines, Aetas (von Bonin, 1931a)	34	1415.6 ±13.13	1406.1 ±11.15	−9.5 −0.7	0.5*
Philippines, Tagals (von Bonin, 1931a)	27	1458.7 ±14.73	1425.2 ±12.51	−33.5 −2.3	1.7*

*Difference not statistically significant.

Dr. Tildesley (1921) followed the satisfactory method of weighing the seed-contents of the skull and then multiplying that weight by a factor in order to give the capacity. Morant used a measuring glass into which he poured the seed-contents of the skull. Hrdlička had a special technique in which fine dry mustard seed was used. He neither weighed the seed nor poured it into a measuring glass, but employed a specially constructed funnel and calibrated tube that registered the volume of seed used in filling the skull (Hrdlička, 1939, pp. 135–138). I have not seen the apparatus in use, but judging from the description and from the capacities obtained there is a tendency for Hrdlička's method to give results somewhat high.

The table (p. 50) indicates that five out of ten comparisons of average cranial capacities show no significant difference (asterisks) between the measured mean and that calculated by the unamended formula of Isserlis. When compared with the carefully measured capacity of Burmese skulls the calculated capacity shows a discrepancy of only 5.8 cc. or 0.3 per cent. But on the average the formula gives for Mongoloids a result which is 4.1 per cent too low.

The Asiatic data are not all satisfactory either in numbers or in the technique of measurement on which they are based. But considered collectively they give a general impression of the true capacities. Details of the provenance of the skulls and discussion of the bibliographical sources are given by Morant (1924), and by Woo and Morant (1932).

The objection to adding 4.1 per cent to the capacity by Isserlis' formula is that we are using 4.1 per cent as the *average* amount by which the capacity by formula falls short of the measured capacity. But instances occur for which the formula needs no addition, or perhaps an addition of less than 4.1 per cent.

Despite the weakness of the data the results tabulated (table, p. 52) give definite and consistent information. The capacities by measurement have a small range for males, 1462–1498 for male skulls, a range of only 36 cc. This is small in view of possible variations in technique in the hands of different workers. Four out of five measured capacities are particularly close. Buriats have 1496, 1484; Torgods, 1489; and Kalmuks of Astrakhan, 1498. The maximum discrepancy of 14 cc. is negligible in an experiment of this kind.

For female skulls there are few data, but perhaps a crude average of 1313 would be near the mark. For male skulls the measured capacities give a crude average of 1486, the capacity by unamended formula of Isserlis about 1454, and by amended formula

ASIATIC SKULLS

Source	Number of skulls	Measured capacity		Capacity by formula of Isserlis		Capacity by formula of Isserlis +4.1%	
		Males	Females	Males	Females	Males	Females
Buriats (Woo and Morant, 1932)	45	Capacity not measured	....	1458(H′) 1477(H)	....	1518 1537	....
Buriats (Reicher, 1912) (seed)	15	1496	....	1458	....	1518	....
Buriats (Woo and Morant, 1932)	15	1484	....	1472	....	1532	....
Mongol Torgods (Morant, 1924)	9	1489	....	1400	....	1457	....
Altai Telenghites, Tartar tribe, South Siberia (Morant, 1924)	45 ♂ 10 ♀	1462	 1269	1427	 1239	1485	 1290
Kalmuks of Astrakhan (Morant, 1924)	35 ♂ 7 ♀	1498	 1320	1461	 1276	1521	 1374
Kalmuks, pooled (Woo and Morant, 1932)	55	Capacity not measured	....	1444(H′) 1454(H)	....	1503 1514	....
Soyotes, west of Lake Baikal (Woo and Morant, 1932)	40	Capacity not measured	....	1486	....	1547	....

1513. The formula without alteration gives 32 cc. too low, and the amended formula gives 27 cc. too high. Apparently we have in this particular instance data to which the formula applies fairly well without adjustment.

JAPANESE

Probably the estimated average capacity of 1475 given by von Bonin (1931a) is the best approximation available; the capacity is given for 129 male skulls. Martin (1928, p. 745) bases his figure of 1485 on shot measurements made by Adachi (1904) on male skulls. Morant (1924) gives 1503. I do not think there is any really satisfactory measurement available. If we use the average L, B, H′ measurements quoted by Morant, the formula of Isserlis yields 1468.

The capacity of 1475 given by von Bonin is based on the largest number of measurements yet pooled, and the figure is compatible with mean capacities of Mongoloid skulls (pp. 50, 52). For 30 female Japanese skulls Morant gives a capacity of 1308. By Isserlis' formula amended the capacity is 1347, and by Adachi (shot) 1319 (see Martin, 1928, p. 745).

Ainu.—For Ainu cranial capacities Koganei (1894) is the original observer, quoted by Martin (p. 745), who gives 1462 for males and 1308 for females. These figures are quoted by Morant (1924), who says that the measurements were made by doubtful means. Martin states that the measurements were made by shot, and therefore they would have to be reduced 5.4 per cent to make them comparable with those known to have been made by fine seed or water. So reduced, the capacities are 1383 and 1237, for males and females.

The Ainu have many features distinguishing them from Mongoloid types and we have no sound criterion for judging the validity of these figures. This ancient reference (Koganei, 1894), which has been quoted and requoted, goes back fifty-two years. The data deserve some experimental verification because the large collection studied by Koganei contains 76 male and 51 female Ainu skulls. Reference to Koganei's original article shows that for measuring capacities he used a *mixture* of shot varying in size from 1 to 2 mm.

CHINESE

The data for capacities of Chinese skulls give a general impression of the size of the Chinese skull. I do not think there is any direct measurement so satisfactory as to provide a crucial test of the validity of a revised formula. For measuring 39 skulls of the Hylam Chinese (from Hainan) Harrower (1928) used fine shot, as he did for the 36

CHINESE SKULLS

Source	Number of skulls	Measured capacity		Capacity by formula of Isserlis		Capacity by formula of Isserlis +4.1% for Mongoloids	
		Males	Females	Males	Females	Males	Females
Hylam Chinese (Harrower, 1928)	39	1428 (shot)	....	1397	....	1454	....
Koreans (Morant, 1924)	17 ♂	1490		1428(H) 1480(H′)		1486(H) 1541(H′)	
	6 ♀		1301		1230		1280
Hokien Chinese from Fookien (Harrower, 1928)	36	1497 (shot)	....	1440	....	1499	....
Chinese, southern (Morant, 1924)	64	[1481]	....	1402(H) 1398(H′)	....	1459(H) 1455(H′)	....
Chinese, Formosa (Morant, 1924)	14	1409	....	1452	....	1511	....
Northern Chinese (Morant, 1924)	10 ♀		1372		1275		1327
	40 ♂	[1456]		1395(H) 1412(H′)		1452(H) 1470(H′)	
Northern Chinese (Morant, 1924 [Koganei])	69	1485 (shot)	....	1464	....	1524	....
Ancient and modern Chinese (Black, 1928)	86	....	....	1406	....	1472	
	25			1417		1483	
	41			1422		1489	
Chinese (general) (Martin, 1928, quotes Broca, number of skulls not given)	..	1518 (shot) becomes 1436 when reduced by 5.4%; 1456 by seed	1308 (shot) reduced	Measurements L, B, H′ not given by Martin (1928)			

Hokien Chinese (1926). Harrower's measured capacity of 1497 is preferable to the rather lower figure for the Hylam Chinese who invaded Hainan and mixed with non-Chinese aborigines.

Although Morant (1924) places a square bracket around the capacity of 1481 to show that it was obtained by doubtful means, the figure should not be rejected, for it is in agreement with 1486 as a crude mean for central Asiatics. Koganei (using mixed shot) obtained a capacity of 1485 for 69 Chinese males.

If we apply the formula of Isserlis (+4.1 per cent) to the L, B, H′ data of Black, who did not measure cranial content, we arrive at capacities of 1472–83–89 for his three samples, and these seem to fit very well with the mean of 1486 for central Asiatics. A measured capacity of 1490 for the Koreans (Morant, 1924) is a good fit with the best of the Chinese data.

There are some examples of L, B, H′ (or H) averages for Chinese male skulls, and one set for Korean male skulls (p. 54). If there were no measured capacities available, and one had to rely on the formula of Isserlis (+4.1 per cent), the crude average capacity would be given as 1484. This is identical with the best examples of measured capacities.

The evidence for capacity of the female Chinese skull is almost negligible, but the crude average by direct measurement is about 1327 and by amended Isserlis formula 1303. The Chinese sex difference of 10.6 per cent is in agreement with several known sex differences in cranial capacity (table, p. 62).

INDIA

For the peoples of India the data are meager. The most reliable figures available for cranial capacities of Tibetans and Nepalese (Mongoloids) are those of Morant, which have been previously quoted (p. 50). Possibly those capacities are somewhat high, since Morant poured the seed into a cylinder.

The principal data for non-Mongoloid peoples of India give 1350 and 1320 as cranial capacities of two samples of male skulls; these values are distinctly lower than those of Mongoloids, for whom we have a capacity of about 1465 (p. 62). The unamended formula of Isserlis fits the dimensions of a group of Tamil skulls very well, yielding 1335 as the capacity. If we compare these figures precisely we have 1350.3 ± 12.94 and 1335.0 ± 10.99, which give a discrepancy of 1.1 per cent, and a Δ/P_Δ value of 0.9 for the difference between the measured and calculated capacities. The Isserlis formula does

Source	Number of skulls	Measured capacity		Capacity by formula of Isserlis		Capacity by formula of Isserlis +4.1% for Mongoloids	
		Males	Females	Males	Females	Males	Females
Tamils (Woo and Morant, 1932)	35 ♂	1350.3 ±12.94	....	1335.0 ±10.99	....	....	....
Hindus, pooled (Woo and Morant, 1932)	90 ♂	Capacity not measured	....	1293	....	....	....
Hindus (Morant, 1924)	34 ♂	1319.9 ±13.13	....	1270.5 ±11.15	....	....	....
Nepalese (Morant, 1924)	6 ♀	....	1249	....	1127	....	1173
Andamanese (Morant, 1924; von Bonin, 1931a)	34 ♂ 18 ♀	1264	1130	1222	1112	....	....
Maravar (Morant, 1922)	17 ♂	1290	....	1273	....	....	....
Veddas (Morant, 1924)	50 ♂	1285	....	1277	....	....	....
Veddas, pooled (Woo and Morant, 1932)	21 ♂	....	....	1267(H′) 1273(H)	....	....	....
Veddas (Woo and Morant, 1932)	26 ♀	....	1178	....	1165	....	....
Annamese (Morant, 1924)	7 ♀ 20 ♂	[1501]	[1368]	1405	1308	1463	1362

not serve so well for a sample of 34 Hindu skulls whose measured capacity is 1319.9±13.13, whereas the unamended Isserlis formula gives 1270.5±11.15. There is a discrepancy of 3.7 per cent, but since the sample is small and the probable errors of the averages are large the Δ/P_{Δ} value of 2.9 is just within the range for differences that may not be significant.

The Andamanese are small people of Negro affinities for whose cranial capacities we have the measured values of 1264 and 1130, for males and females respectively. The formula of Isserlis, which was based on a study of African Negro skulls, yields 1222 and 1112, so showing a slight discrepancy of 1.6 per cent for female skulls, and 3.3 per cent for those of males. The size of the skull (and therefore the cranial capacity) is closely correlated with stature and weight of body. We would therefore expect the cranial capacities of the diminutive Andamanese to be less than those for Negroes (1346 male, 1192 female, p. 32).

The Veddas of Ceylon are a pre-Dravidian people of slender build and small stature. They are definitely non-Negro and non-Mongoloid. In their wavy hair and physiognomy they resemble Australian aborigines. Since they are of meager build the measured cranial capacity of 1285, and by Isserlis (unamended) 1277, is plausible. The only measured and calculated capacities for females are 1178 and 1165 respectively. These figures are reasonably close to those for Australian aborigines (p. 37) whose most satisfactory measured samples yield 1294 for males and 1147 for females.

The Mongoloid Annamese, whose cranial capacity measurement is marked by Morant as doubtful, have, nevertheless, a male cranial capacity of 1501, which compares fairly closely with a general mean of 1485 for central Asiatics and for Chinese males.

JAVA AND BORNEO

Dr. von Bonin (1931a) states that Javanese and Dayak skulls in the laboratory at Leiden were bisected and mounted in such a way that measurement of capacities was not possible, but the average L, B, and H′ measurements are given. If two samples are available for the same tribe or region, selection of the larger sample has been made. To the cranial capacity given by formula of Isserlis, 4.1 per cent has been added, because experiment has shown that for Mongoloids (p. 51) the unrevised formula gives a result that is too low.

Javanese skulls are of smaller capacity than any of the Mongoloid skulls yet recorded. For Javanese males we have a crude average of

JAVANESE SKULLS

Source	Number of skulls	Capacity by formula of Isserlis	Capacity by revised formula of Isserlis	Difference of revised capacity from general Mongoloid mean of 1465 (see p. 63)
Miscellaneous (von Bonin quotes Schmidt)	40 ♂	1401	1458	−7
Batam	22 ♂	1297	1350	−115
Batavia	33 ♂	1346	1401	−64
Middle Java	30 ♂	1368	1424	−41
Eastern and various	35 ♂	1395	1452	−13
Madura	15 ♂	1389	1446	−19
Martin (1928, p. 745) quotes Broca (used shot)	....	1590 ♂ reduced 5.4% becomes 1504 1396 ♀ becomes 1321	Measurements not available for calculation by formula.	

1422 in comparison with averages of 1465 and 1485 for other Mongoloid data.

For cranial capacities of Dayaks we shall have to use the L, B, H′ measurements given by von Bonin (1931a, p. 84). The number of male skulls is 55, and the average dimensions when used in the Isserlis formula (+4.1 per cent) give 1418 and 1428, with H′ and H respectively as measurements for cranial heights. The measured cranial capacity of 1422 for the Javanese agrees well with the calculated capacities of 1418 and 1428 for Dayaks of Borneo.

IRANIAN SKULLS

Krogman (1940) does not give the cranial capacities of skulls, but he supplies the average L, B, H′ measurements. According to the formula of Isserlis the capacities for the various types of Iranian skulls mentioned by Krogman would be:

Hissar III, Mediterranean Type: 51 skulls (♂), 1364; 32 skulls (♀), 1277.
Hissar III, Proto-Nordic Type: 39 skulls (♂), 1485.

Since the capacity of these skulls has not been measured we do not know how near to the true measurement the formula of Isserlis has attained, and we do not know what to add or subtract from our result. The capacity of 1485, which the Isserlis formula gives for the Proto-Nordics, is a likely result when compared with a general European average of 1488 and an average of 1472 for Old English skulls. Krogman's Hissar III, Mediterranean Type, male skulls

have an average capacity of 1364 by Isserlis' formula. This places them close to the Tamil male capacity of 1350 (Woo and Morant, 1932).

SUMMARY AND CONCLUSIONS

This research on cranial capacities was written to combine the results set forth in many articles, and to add the data obtained for a large collection of Melanesian skulls in Chicago Natural History Museum. Many articles have been published since Martin (1928) prepared a table showing variation of cranial capacities by race, sex, and method of measurement, but his data often lack a statement of the number of skulls measured for each capacity quoted.

The desire for calculating cranial capacities, and so arriving quickly at a conclusion that could be reached only by much tedious experiment, has led to the construction of many formulae. These make use of the average length, breadth, and height measurements of a series of skulls whose average cranial capacity is required.

I found that the general formula of Lee (1901) gave improbable results for a large collection of 124 males and for 70 females of New Guinea; neither does the formula give a probable error of the mean. On the contrary, the formula of Isserlis gave, by a few minutes of calculation, cranial capacities almost identical with those obtained by measurement with mustard seed. The satisfactory application of Isserlis' formula to the data for Melanesian crania, and to a few other racial examples chosen at random, led to a systematic attempt to apply the formula to a large number of cranial measurements. This was done in order to find what amendment, if any, would be required to make the formula applicable to large or small collections of skulls of either sex and of different races.

Preliminary work was confined to the preparation of a table showing the degree of approximation of calculated capacities to those that had been directly measured. In 73 out of 114 instances the average cranial capacity obtained by formula of Isserlis showed no significant difference from the measured capacity.

The latter part of the work consisted of applying the amended formula of Isserlis to data for which the measured capacities were not so reliable, or to data that gave the necessary L, B, H′ (or H) measurements but lacked a statement of cranial capacity.

Usually the formula of Isserlis does not require a radical adjustment in order to adapt it to the average L, B, and H′ measurements

for cranial series from different races. The formula was found to make a satisfactory estimate of capacities of several groups of Egyptian and of many groups of Melanesian skulls, and also of Polynesian skulls. For the small series of Hindu and Tamil skulls the averages obtained by direct measurement and formula showed no significant difference.

The formula of Isserlis does not give acceptable results for Australian or Tasmanian male skulls, but the formula of von Bonin, which was worked out on a series of skulls from New Britain, is satisfactory for Australians and Tasmanians of both sexes.

For some series of Mongoloid crania the formula of Isserlis gives capacities in close agreement with the measured capacities, but on the average the Isserlis formula gives a result about 4 per cent too low.

For European skulls the formula of Isserlis gives, on the average, a result that falls short of the measured capacity by about 3 per cent.

By studying 114 applications of the formula of Isserlis made by statistical methods (pp. 25–58) we can prepare a frequency distribution of the percentage discrepancies. In 27 cases out of 114 the capacity by formula disagrees with the measured capacity by less than 1 per cent, and the size and frequency of the remaining discrepancies are shown in the following table. The upper figures are percentages and the lower figures are the number of instances giving discrepancies for the class intervals 1 per cent, 1 to 2 per cent, 2 to 3 per cent, and so forth.

Percentage....	0–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8	8–9	9–10	10–11
Frequencies...	27	25	18	14	12	7	6	2	1	1	1

The tables on pages 61–63 are a summary of the data relating to:

(1) Comparisons of cranial capacities by direct measurement and formula, for large pooled series (pp. 61–63).

(2) Sex ratios (p. 62). These agree very well for different races when we consider the paucity of data at our disposal. The sex ratio of Egyptian cranial capacities is low, but one must remember that, in any racial series in which males are of slender build and small stature, the cranial capacities, which are correlated with height and body weight, would naturally tend to give a small sex ratio. Unfortunately there is scarcely any information available for body weights of the peoples whose cranial capacities we have considered. I have no explanation to offer for the small sex ratio of Tasmanians,

except that the collections of crania are small, and of course mistakes in sexing the skulls would lead to misapprehensions concerning the sex ratio for cranial capacities.

(3) Average measured cranial capacities for different races (p. 63). These figures are necessarily approximate and tentative, but I believe they give an accurate summary of all we know of the racial differences. Evidently there are two main categories of capacities. The block in the left-hand column is a 1400–1500 group of Europeans, Mongoloids, American Indians, and Polynesians. The right-hand column is a 1200–1300 capacity value for Negroes, Melanesians, Hindus, Tamils, Australian aborigines, and Tasmanians.

On the whole, the evidence indicates that the formula of Isserlis may be cautiously used as a time-saving device, and at least the formula can, sometimes with amendment, be safely employed as a check on experimental work. But no formula can be so trustworthy as careful measurement, and there is great need for extensive application of well-standardized technique in order to provide more reliable data relating to cranial capacities.

SUMMARY OF CRANIAL CAPACITIES

Males and Females of the Same Ethnological Groups

People	*Males*			*Females*		
	Measured capacity	Calculated capacity	Difference in percentage	Measured capacity	Calculated capacity	Difference in percentage
African Negroes	1346	1349	+0.2	1172	1158	−1.2
Tasmanians	1256	1360	+8.3	1198	1254	+4.6
Australian aborigines	1294	1310	+1.2	1125	1175	+4.4
Old English	1472	1442	−2.1	1320	1274	−3.5
Polynesians	1451	1477	+1.8	1324	1328	+0.4
Melanesians	1345	1344	−0.1	1216	1220	+0.3
Melanesians (Except Fijians and Loyalty Islanders)	1323	1317	−0.5	1192	1190	−0.1
Fijians and Loyalty Islanders	1439	1458	+1.3	1288	1310	+1.7
Approximate averages (All samples, pooled)	1373	1381	+0.5	1237	1240	+0.2

SUMMARY OF CRANIAL CAPACITIES

Groups of Males, without Corresponding Female Groups

People	Measured capacity	Calculated capacity	Difference in percentage
Miscellaneous Mongoloids	1465	1404	−4.1
Europeans, ancient and modern	1488	1435	−3.6
American Indian and Eskimo	1460	1440	−1.4
Hindu and Tamil	1335	1303	−2.4

Cranial capacities of females are less than those of males by the percentages given in the table below. These differences are based on capacities given in the foregoing tables.

SEX DIFFERENCES IN CRANIAL CAPACITIES

Region	Percentage difference in sex capacity	Region	Percentage difference in sex capacity
Egypt, Dynasties 26–30	9.6	Old English	10.3
Egypt, Dynasties 18–21	9.9	Polynesian	8.7
Egypt, Prehistoric Naqada	6.5	Melanesian	9.6
African Negroes	12.9	Melanesian (Except Fijians and Loyalty Islanders)	9.9
Australian aborigines	13.1	Loyalty Islanders and Fijians	10.5
Tasmanians	4.6	North American Indian (Hrdlička, 1927)	11.2
Eskimo (Stewart, 1939; estimated capacities)	12.1	Tepe Hissar, Iran (Krogman, 1940; estimated capacities)	6.8

By use of the cranial module $\frac{L+B+H}{3}$, Hrdlička (1925, p. 250) concluded that the female brain is on the average about 7 per cent smaller than that of the male. Comparison by direct measurement and by formula suggests that the estimated sex difference given by Hrdlička is somewhat too low. The formula as expressed by Hrdlička gives an answer that must be multiplied by ten to express the cranial capacity in four integers.

AVERAGE MEASURED CRANIAL CAPACITIES

Different Peoples (Males), in Descending Magnitude

Region	Measured capacity	Region	Measured capacity
Europeans, ancient and modern	1488	African Negroes	1346
Old English	1472	Melanesians	1345
Miscellaneous Mongoloids	1465	Hindu and Tamil	1335
American Indian and Eskimo	1460	Melanesians (except Fijians and Loyalty Islanders)	1323
Polynesians	1451	Australian aborigines	1294
Fijians and Loyalty Islanders	1439	Tasmanians	1256

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