THE AUSTRALIAN ABORIGINAL BRAIN

By H. H. WOOLLARD,
Department of Anatomy, University of Adelaide

THE intrinsic interest of the aboriginal brain, the comparative rarity of studies of well-preserved specimens, and the probability that material will become more and more difficult to obtain, are sufficient reasons for the following notes.

The material likely to present itself at the Anatomical Department in an Australian city at this date must be always subject to the suspicion that it may not be derived from full-blooded aborigines. All the four brains that have been examined are said to be those of full-blooded aborigines, yet the specimen numbered three is open to suspicion. The suspicion is based not only on discrepancies in the pattern of the fissures, but also in marked differences in measurement. However, be this as it may, Brain 1 appears to be the most distinctive and it appears to repeat very faithfully the pattern of the brain numbered 4 in Duckworth's series. Duckworth remarked that this brain appeared to be the most primitive in his series.

In view of the few brains already described and the extreme unlikelihood that the numbers will ever be considerable, little value can be attached to percentage calculations. The comparison of drawings and photographs shows that the brain of the aborigine varies considerably, as do all brains, in regard to those fissures which are least stable. Though it may seem an extremely biassed procedure, perhaps most might be obtained from such a study as this by dwelling on the brain that seems most primitive in all features. Measurements of the length and depth of sulci, the frequency of single and bifid terminations, and so forth, are so variable that they seem useless. Moreover, it appears that no standard exists for any certain comparison. For instance, it seems quite misleading to compare a dolichocephalic brain numerically or in its detailed fissural pattern with any other brains, say European, unless these have been first standardised in regard to dolichocephaly or brachycephaly. A recent investigation by Kappers has shown that the Dutch brachycephalic brain is much more like a Chinese brain than it is like a Dutch dolichocephalic brain. Such an observation also invalidates many comparisons that have been made not only with European brains, but also with the brains of new-born, for in these any brachycephaly that is present is greater than when they are full grown. The anthropoids being mostly brachycephalic, the same criticism can be urged though with less force since the comparisons with these are confined to the more stable elements in the brain.

When this study was begun it was hoped that a description of the fissures based on their relations to the histologically differentiated areas of the brain might be achieved. It was intended to apply the method used by Elliot Smith in his study of the Egyptian brain where he was able to utilise the variations in the thickness of the cortex and the changes of cortical bands to define such areas. I found, however, that these formalin-fixed brains did not disclose with sufficient sharpness these differences, and no significant facts were obtained outside the visual area. There can be no doubt, however, that it would be a distinct advance in anthropological method if the pattern of the cortex were elucidated and compared by his method.

SOURCE OF THE MATERIAL

Brain 1 was obtained from the Mental Hospital and belonged to a full-blooded aborigine from Welgena. The cause of death was congestion of the lungs and cardiac failure. He was 5 feet 5 inches in height and was 56 years of age. The brain was fixed *in situ* and the preservation was excellent.

Brain 2 was also obtained from the Mental Hospital and belonged to a full-blooded aborigine from Horse Shoe Bend in the Northern Territory of Australia. This man was 5 feet 8 inches high, was 24 years of age, and died of pulmonary tuberculosis. The brain was fixed *in situ* and the preservation was excellent.

Brain 3 came from a general hospital. His age was 36, but no other details of his physique are known. The cause of death was heart failure with some cirrhosis of the liver. The preservation was excellent.

Brain 4 was badly preserved and distorted and could only be used for one or two points in the following description.

The fact that two of the brains came from the asylum is, I believe, without any significance in the results which follow.

THE FISSURATION OF THE BRAIN

Exposure of the Insula

Using Brain 1 as a sort of standard, it is noted that exposure of the insula occurs in both hemispheres. In Brain 2 the exposure is marked in the left hemisphere but absent in the right. In Brain 3 the insula is covered in both hemispheres. Brain 4 is useless for comparison because of bad fixation and distortion. Duckworth's material created difficulties, since he was unable to discount distortion from imperfect fixation, the effects of removing the vessels and membranes, and what was due to defective operculation. Nevertheless he was inclined to regard exposure of the insula as a character of the aboriginal brain and as being due to defective development of the orbital operculum. I believe it is in a slight degree a feature of the aboriginal brain, for in well-fixed material it is possible to get rid of all the difficulties except those of the range of variation and dolichocephaly. From the comparisons that can be made with brains available here of dolichocephalic type its importance as a feature

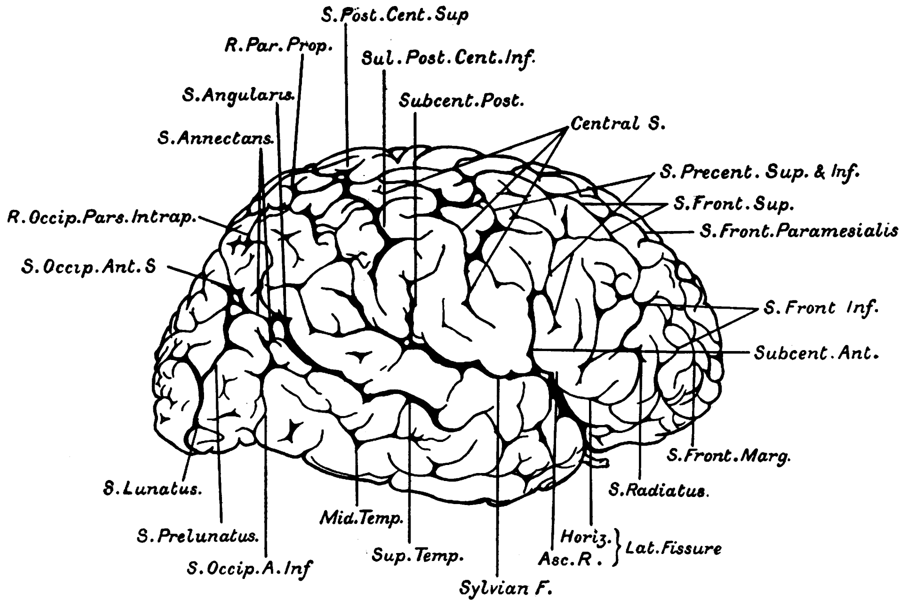

Fig. 1. Brain 1. Right hemisphere. Lateral view.

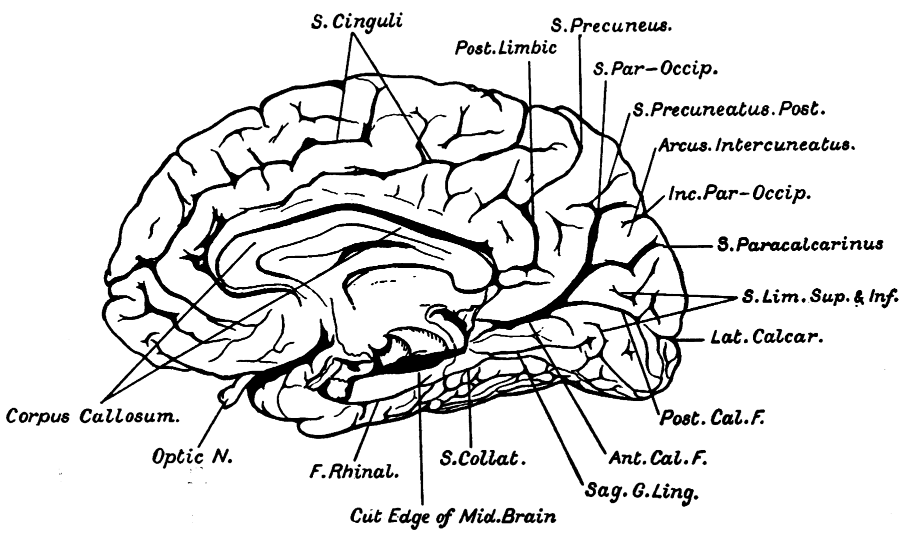

Fig. 2. Brain 1. Right hemisphere. Mesial view.

of the aboriginal brain seems enhanced since it appears that the insula is covered even in the most dolichocephalic examples of European brains.

In Brain 1 the fronto-parietal operculum of both hemispheres is defective, in Brain 2 it is present but imperfect, especially in the left hemisphere, while in Brain 3 it is well developed on both sides.

The anterior rami of the lateral fissure are extremely variable. The outstanding point seems to be the close proximity of the ascending limb with the inferior portion of the precentral sulcus. In Brain 3, the arrangement is more like the usual textbook illustration. In the right hemisphere of Brain 1, the ascending limb does not emerge from the fossa. It is tempting to try, but difficult, to establish any significance in the arrangement of these rami. Much variation has been recorded in all the brains examined. The observations of other observers have been tabulated by Duckworth. The lateral fissure calls for no particular comment. There is nothing peculiar to note in regard to the sulcus circularis, the limen insulae, the central sulcus, the gyri breves or gyrus longus, except that in one case the breves are arranged as a series of parallel gyri equal to one another and to the gyrus longus.

THE ACOUSTIC AREA

In Brain 1, the acoustic gyri are separated from the lateral surface of the superior temporal convolution by a deep indentation. In Brain 2 the posterior transverse gyrus is large and prominent in the right hemisphere. The acoustic area however passes on to the lateral surface without interruption. The same extension occurs in Brain 3.

The area circumambiens can be defined by the middle portion of the superior temporal convolution. This middle component of the superior temporal sulcus is separable from the anterior and posterior parts by the presence of sunken gyri within the fissure. In two hemispheres (1, left and 2, right) the interruption of the superior temporal convolution is complete, and the superior temporal convolution unites with the middle temporal convolution. This feature is perhaps of some significance in a dolichocephalic brain. The posterior ascending limb of the superior temporal sulcus is easily separable from the middle by means of a gyrus which may be either superficial or slightly depressed within the sulcus but easily seen from the surface, or sunken so that the lips of the sulcus have to be pulled apart in order to discover it. Brain 3 shows a very marked reduction in the width of the superior temporal convolution. In this brain the width drops to 9 mm., while in the other hemispheres measured at the same spot, it is 15 mm.

The middle temporal sulcus is somewhat irregular but probably less so than in other dolichocephalic brains. In one hemisphere it is continuous, but in the others it occurs in two parts, an anterior and posterior.

The inferior temporal sulcus is variable. In the right hemisphere of Brain 1, it forms a continuous sulcus running parallel with the collateral fissure. The

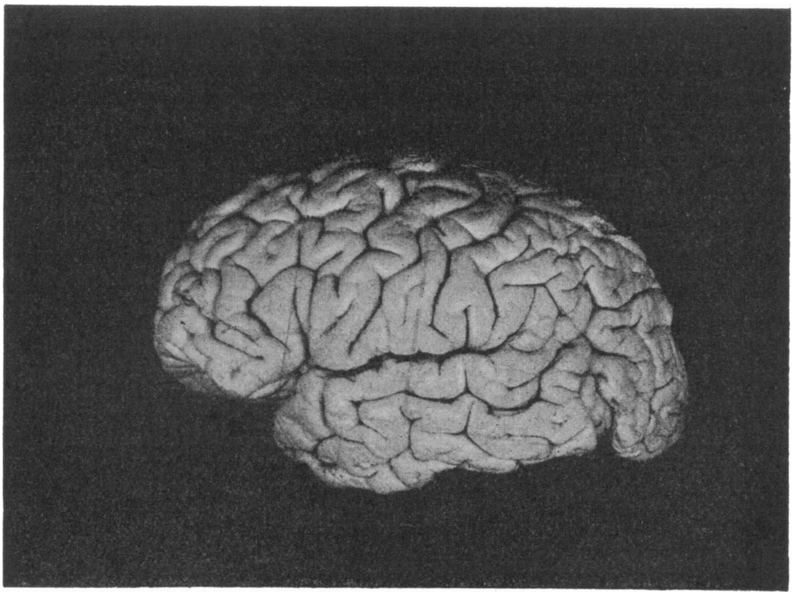

Fig. 3. Brain 1. Left hemisphere. Lateral view.

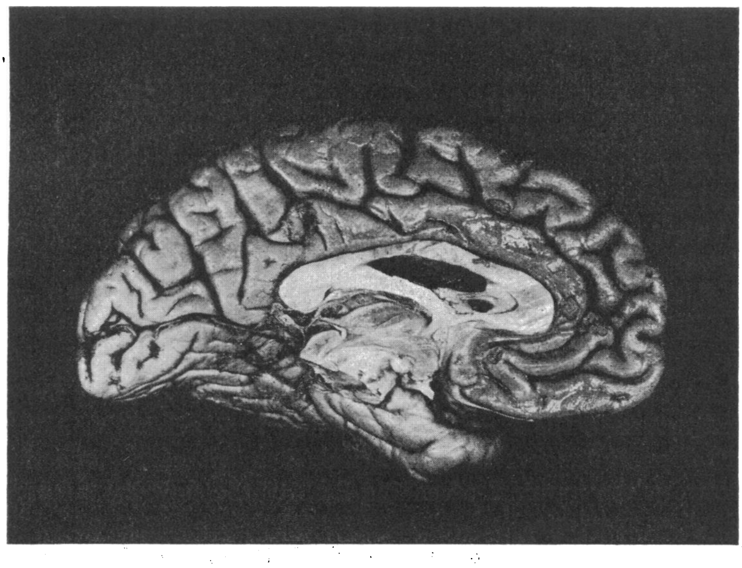

Fig. 4. Brain 1. Left hemisphere. Mesial view.

same arrangement also occurs in the left hemisphere. In both it travels medially around the front end of the collateral, either ending near to or joining with the rhinal fissure. In Brain 2, left hemisphere, it forms a continuous fissure. At its middle it is joined by the collateral fissure. On the right side in Brain 2 the condition is practically the same, except that it is not actually joined by the collateral. In Brain 3, the fissure is broken up into at least three parts in both hemispheres.

In Brain 1 the pararhinal area is very much reduced in size by the encroachment of the superior temporal sulcus. In Brain 2 the pararhinal area is well defined. In Brain 3 it is again much reduced in size.

The temporal area as a whole appears to be small. In the simplest brain the sulci tend to be continuous fissures, except in the case of the superior temporal fissure in which the components tend to remain separate. In the same brain the auditory receptive area is better demarcated from the lateral surface than in the others. On the whole it does not seem possible to assign any distinctive features to the acoustic area of the Australian brain.

VISUAL AREA

The calcarine fissure falls into three portions—anterior, posterior, and lateral (superior occipital sulcus of Duckworth and others). In only one hemisphere (the right of Brain 3) is a typical sulcus lunatus absent.

The interval between the posterior calcarine and the lateral calcarine is marked by the presence of vertical gyri. These may be elevated, depressed, or at the same level as the surrounding cortex. There may be one, two, or three of them. They are least conspicuous in the left hemisphere of Brain 1. The limiting sulci are easily identified and the sulcus sagittalis lingualis is present in all. The sulcus parieto-occipitalis (sulcus precuneus of Duckworth) is followed in all hemispheres by an exposed arcus intercuneatus which is cut at the superomesial border of the hemisphere by the incisura parieto-occipitalis. This is followed by a sulcus paracalcarinus which is usually continued on to the lateral border as the lateral superior occipital sulcus.

The lateral calcarine sulcus, beginning as a V-shaped fissure, turns round the occipital pole and ends on the lateral occipital surface without bifurcation. Beyond this lies the curved lunate sulcus which can be identified without doubt in all brains except the right hemisphere of 3. From the middle of the lunate the sulcus prelunatus extends forwards along the lateral surface terminating anteriorly in the anterior occipital sulcus. This is joined by an annectant fissure to the angular sulcus which is coincident usually with the superior temporal fissure. In Brain 1, right hemisphere, a distinction can be made between the terminal ascending limb of the superior temporal sulcus and the sulcus angularis.

This pattern can be made out most easily in the two hemispheres of Brain 1. The same pattern exists in the remaining hemispheres, but the arrangement

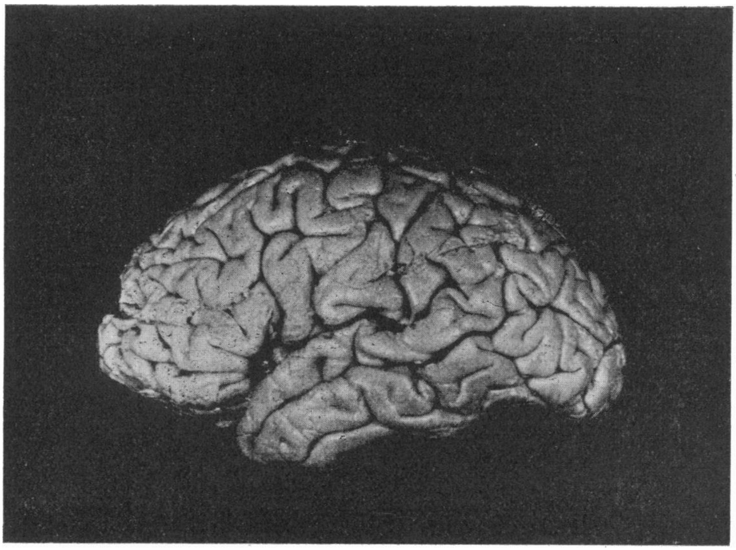

Fig. 5. Brain 2. Left hemisphere. Lateral view.

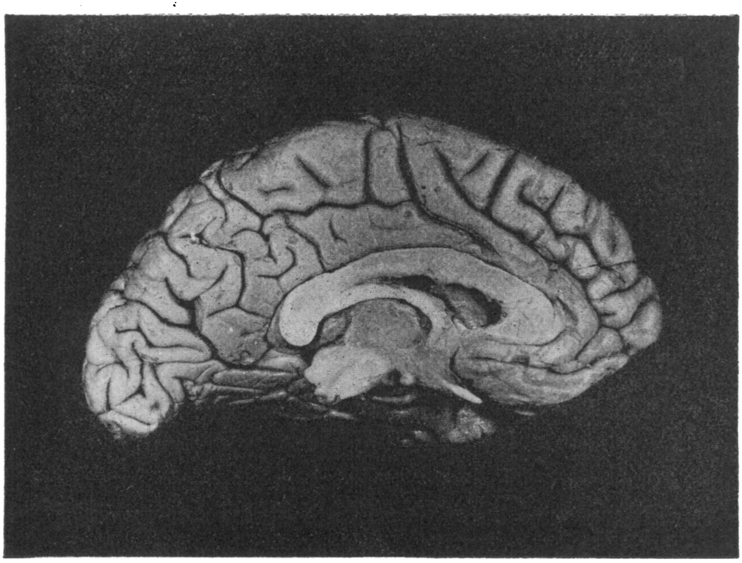

Fig. 6. Brain 2. Left hemisphere. Mesial view.

is not so clear. The detailed differences do not appear to be of any moment since the variation is in no two cases the same.

As some importance has been attached to the depth of the fissures, a few comparative measurements are included here:

Brain No.	Hemisphere	S. par.-occip. (mm.)	S. calcar. (mm.)	S. centralis (mm.)
1	R.	17	15	18
	L.	16	15	18
2	R.	22	15	22
	L.	19	18	20
3	R.	20	20	20
	L.	15	19	17

The only inference that can be drawn from these figures perhaps is that in Brain 1, where the visual area has achieved a more marked external definition, the calcarine fissure tends to be shallower.

When compared with European brains the significance of the frequency of the lunate sulcus is apparent. Duckworth computed when he wrote that 60 per cent. of all aboriginal brains, so far described, possessed a lunate sulcus. The addition to his series of the above would raise that percentage still further (seven out of eight hemispheres examined). The significance and meaning of this sulcus was first deciphered by Elliot Smith. Examination of the cortex in these cases confirms his interpretation. It is the one certain primitive feature yet discerned in the human brain. The presence of the paracalcarine sulcus seems very constant and this may be of some significance in emphasising the primitive character of this region of the brain. There is one other feature which perhaps is worth recording, and that is the tendency towards operculation that occurs at the extremity of the inferior arm of the anterior occipital sulcus. The operculum separates the peristriate area from the occipito-temporal area and is especially marked in Brain 1. It is very obvious in the left hemisphere of this brain.

The sulcus collateralis does not join the rhinal fissure in the left hemisphere of Brain 1. In the right these two are connected only superficially, while near this junction a lateral prolongation of the collateral occurs which separates the pararhinal from the temporal areas. Posteriorly it terminates in a transverse expansion bounding the peristriate area. In Brain 2 this fissure joins the inferior temporal sulcus. In the left hemisphere of Brain 3 it joins with the rhinal fissure anteriorly.

THE PARIETAL AREA

A tendency for the sulcus centralis to join the Sylvian fissure has been raised to the rank of a distinctive attribute of the Australian brain. Duckworth however in his series failed to confirm this. In the right hemisphere of Brain 1 there are extremely indirect communications with the Sylvian by way of the sulcus subcentralis anterior, and still less so by way of the sulcus

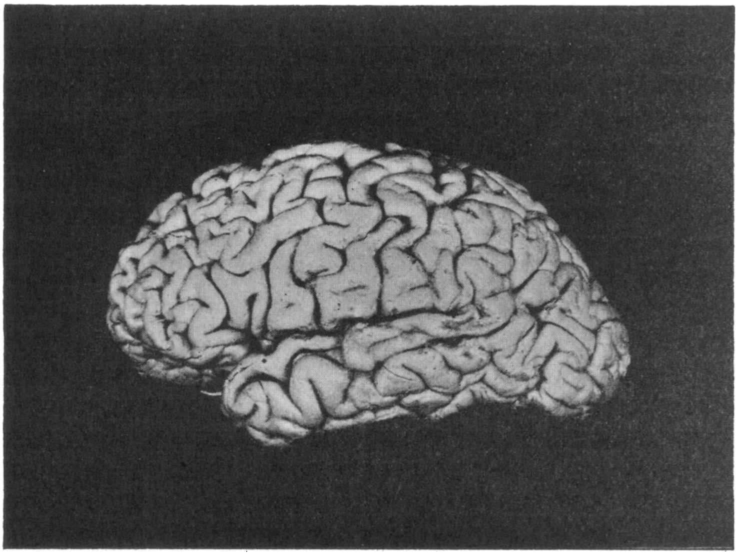

Fig. 7. Brain 3. Left hemisphere. Lateral view.

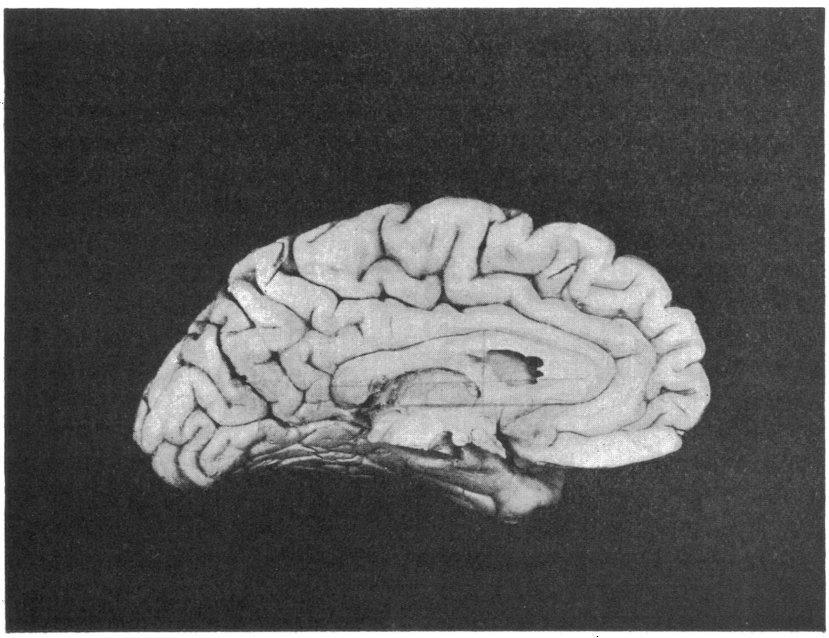

Fig. 8. Brain 3. Left hemisphere. Mesial view.

subcentralis posterior. In the left hemisphere there is no indication of any continuity, even indirectly.

In Brain 2 in the right hemisphere there is no communication with the Sylvian fissure. On the left side, however, the central sulcus is joined by the sulcus subcentralis anterior and is thus brought into communication with the Sylvian fissure.

In Brain 3 no such communication exists on the right side, but on the left side the central sulcus is again joined by the sulcus subcentralis anterior, thus establishing communication with the Sylvian. In the very imperfect Brain 4, the sulcus centralis is excluded from the Sylvian fissure.

Duckworth found such communication present in only one of his hemispheres, while in half of the cases of the well-preserved brains in this series it is present. The feature is thus perhaps of some importance.

Another point that is of some interest is the relation of the fissure to the superomesial border. In all cases there is a well-defined continuation of the fissure to the superomesial border and in some cases beyond. There seems to be no substantial difference in the arrangement from that of other brains. By the examination of unstained cortical strips no evidence was obtained of extension forwards of the Rolandic area. A well-defined lobus paracentralis limited behind by the sulcus cinguli and in front by the sulcus paracentralia is present.

The sulcus intraparietalis consists of four genetically distinct furrows. Duckworth observed that in 47 per cent. of his cases the occipital element did not fuse with the intraparietal. In this series all four elements are continuous though the fissure can easily be split up into its components by the presence of annectant gyri slightly depressed below the surface of the brain. The point that impresses one is the nearness of the fissure to the superomesial border so that the superior parietal lobule is reduced to the smallest proportions. The reduction is marked in Brains 1 and 2, while in 3 the width is normal.

The cuneus is defined by the sulcus precuneus, the terminal ascending piece of the sulcus cinguli, and inferiorly by a sulcus paracentralis.

The gyri supramarginalis and angularis are difficult to define owing to the lack of regularity in the fissures of this region. The sulcus angularis joins with the superior temporal sulcus below and usually directly or indirectly links up with the intra-parietal above. Duckworth believes the parietal area is small relatively. The tendency for the intraparietal sulcus to approach the superomesial border tends to enlarge the area occupied by the supramarginal and the angular gyri.

FRONTAL REGION

The inferior limb of the precentral sulcus is confluent with the superior portion in only two hemispheres out of six. This is much less than in Duckworth's series (62·5 per cent.) and thus brings this series into greater conformity with the European brain. Below, in the right hemisphere of Brain 1, the inferior precentral is joined to the Sylvian fossa by the anterior subcentral fissure. In the left hemisphere the sulcus subcentralis anterior is present, but the inferior precentral is joined to the Sylvian fossa by means of the sulcus diagonalis. In Brain 2 on the right the junction with the Sylvian fossa by means of the anterior subcentral is just discernible, while on the left side the fissure is directly continuous with the fossa.

In Brain 3 both inferior precentral sulci approach and are only narrowly excluded from the fossa by a small depressed gyrus. The junction with the fossa appears to be a variable feature in the European brain and perhaps the frequency of this union is slightly higher in the Australian brain. The sulcus subcentralis anterior is present in four hemispheres, about the same proportion as Duckworth found. The sulcus radiatus of Eberstaller is present in all cases. This makes the brain like that of the European foetus (Duckworth).

A fronto-marginal sulcus and sulci rostrales can be distinguished in all brains, thus making the Australian brain resemble the European brain.

In all cases the superior frontal sulcus is continued almost to the frontal pole and is directly continuous with the superior precentral sulcus. In only one hemisphere (Brain 3, right hemisphere) is the sulcus precentralis medius independent of the superior precentral sulcus. Duckworth also found one hemisphere in which this occurred and believed it to be a Simian feature.

A sulcus frontalis medius is present in all. Usually well defined and separate at its posterior extremity, anteriorly it becomes very irregular and fuses with the fronto-marginal sulcus. The tendency of this fissure to become an independent sulcus is noted by Duckworth and regarded by him as a very distinctive feature of the aboriginal brain. This series confirms in part the data of Duckworth, though in only two hemispheres can it be said to be distinct from the fronto-marginal sulcus, a very much smaller proportion than in his series.

In all hemispheres the superior frontal gyrus is divided by a longitudinal furrow more or less regular, running parallel with the superior frontal sulcus. A similar furrow is present on the mesial aspect of the brain. Both are present in Brains 1 and 2, while in Brain 3 the lateral paramesial fissure is present on the left side and a medial paramesial on the right side.

The sulcus cinguli is present with the same form in all.

The excellent and intensive study of the aboriginal brain made by Duckworth has facilitated enormously the work of anyone who undertakes a similar study. Full use of his paper has been made by me, and it would perhaps be suitable at this point to see what agreement the present study gives in regard to the fissuration when compared with his.

(1) Curvature of the fissure rhinalis. A boldly curved fissure rhinalis is evidence of lowly affinities, says Duckworth. This character Duckworth found once. This feature occurs in Brain 1, the simplest of the series. It is not present in the others.

(2) Exposure of the insula. The evidence for this has been discussed above. The present series being excellently preserved removes the doubt felt by

Duckworth on this point, and exposure of the insula is to some extent a distinctive feature of the aboriginal brain.

(3) Discontinuity of the components of the sulcus intraparietalis impressed Duckworth with the primitive quality of the aboriginal brain, particularly the separation of the superior postcentral from the parietalis propius. The present series does not confirm this opinion, for in all the sulcus is continuous throughout.

(4) In regard to the retrocalcarine fissure and the sulcus lunatus, the present series amply confirms, and even carries further, the inferences to be drawn from this feature. In the identification of these fissures Elliot Smith has discovered so far the only reliable criterion of a primitive human brain. The present series indicates that these features are present practically in all pure-blooded aborigines.

(5) The gyrus cuneus and the annectant gyri are as Duckworth states.

ANTHROPOMETRY

In this part of the study of the aboriginal brain the recent work of Kappers has been followed. Kappers has insisted on the absolute necessity of using only properly preserved material, and has drawn up a series of measurements which have the merit of simplicity and at the same time the virtue of expressing all the information desired. Kappers' series of dolichocephalic Dutch brains furnish an excellent basis for comparison with the Australian brain.

Taking first the brain index, i.e. the figure derived from the greatest diameter of the brain over its greatest length, in Kappers' series of seven Dutch brains this index ranges from 75·2 to 80·3; in this series of well-preserved brains the indices are:

Brain	Greatest diam. (mm.)	Greatest length (mm.)	Brain index
1	126	173	72·83
2	124	173	71·68
3	128	170	75·30

This then is a degree of dolichocephaly very much greater than that in the brains chosen by Kappers.

The height index is obtained by taking the height of the parietal perpendicular from the lateral horizontal plane, i.e. a horizontal plane connecting the orbital operculum with the base of the occipital lobe. This index is of interest in the Australian because of the marked flattening of the vertex of the skull in many of them, and this causes what has been described as the ill-filled cranium of the Aborigine.

Following the suggestion of Kappers, these measurements have been obtained from photographs, a much more accurate method than measuring them on the actual brains. The results are:

Brain	R.	L.
1	0·521	0·502
2	0·500	0·522
3	0·481	0·477

The average works out for the height index at 0·5. In Kappers' series of dolichocephalic Dutch brains the average for the height index is 0·491. Thus the two are in practical agreement. The relationship of height to length is thus in the same proportion as in dolichocephalic brains generally, and there is no reason to suppose that the Australian cranium is an ill-filled one. Duckworth writes, "As compared with European crania, that of the aboriginal Australian appears to be incompletely expanded and this is ascribed to defective growth of the cerebrum." The series considered by Duckworth failed, however, to confirm the above quotation. This, he thought, was due to their lack of adequate preservation.

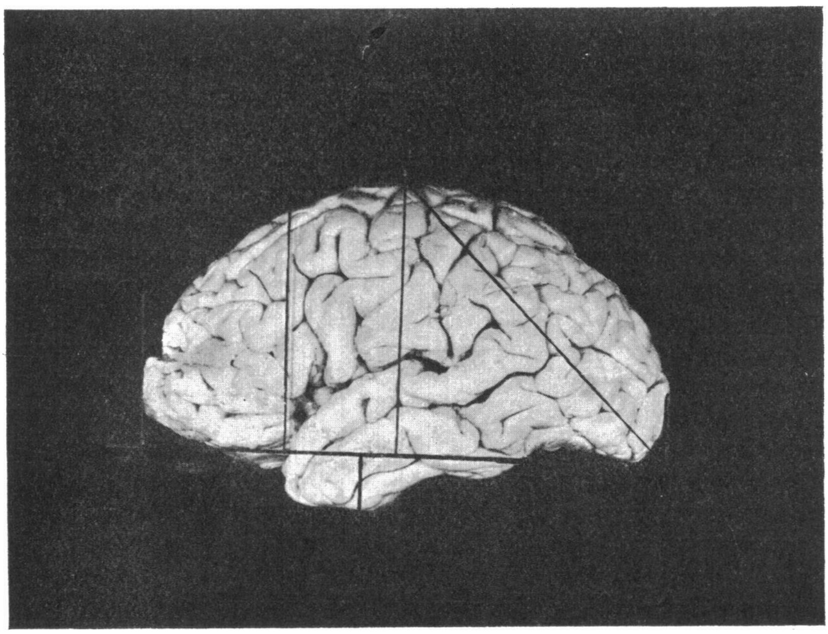

Fig. 9. The lines indicate the measurements which have been used in the anthropometry of aboriginal brain.

The occipital index being the parietal perpendicular divided by its distance from the occipital perpendicular, is subject to some fluctuation, for the highest point of the parietal lobe may cause a considerable shift in the position of the parietal perpendicular. In this series the line of the parietal height lies more anteriorly than the illustration of Kappers shows. This shift is particularly true of Brain 3. The other two give almost identical figures with those of the Dutch dolichocephalics. These average 1·19. The average for two brains of the present series is 1·09, while the third falls to 0·8, this being due to the anterior position of the parietal perpendicular. When the distance to the occipital perpendicular is measured from a constant point, namely, the point where the central sulcus cuts the superomesial border, the index of Brain 3 rises to 1·0. It has already been seen that the ratio of the parietal height to the lateral horizontal is the same in the Dutch and Australian brains. When this same height is compared with the distance from the occipital pole the index is diminished. This diminution in the value of the index may arise from the increase in the distance to the occipital perpendicular, and may be explained by the increase in the area of the visual territory.

The temporal index is obtained by dividing the temporal perpendicular by the lateral horizontal distance. The indices vary, but the average is 0·127. Kappers' series gives an average of 0·145. Therefore the temporal area may be relatively reduced in the aboriginal brain.

The frontal height index is obtained by dividing the perpendicular from the lateral horizontal to the upper border through the front of the temporal pole (measured from the lateral horizontal) by the lateral horizontal. The average for the Australian is 1·728. The average for the Kappers' series is 1·85. This again indicates a reduction in the Australian brain.

The frontal length index is the distance of the insular perpendicular from the frontal pole perpendicular divided by the lateral horizontal. The Australian average is 0·254. The Kappers' series averages 0·231. The higher value of the Australian indicates that there may be a greater extension in the frontal region.

It appears from all these measurements that those which depend on vertical measurements are decreased in the Australian, while those depending on horizontal measurements are increased. It may therefore be concluded that in the Australian brain the relative magnitudes of the brain are much the same as in the European brain. What differences are present depend entirely on the greater dolichocephaly of the Australian brain.

The callosal height, being the callosal perpendicular divided by the callosal length, is for the Australian brain 0·310, while for the Kappers' series it is 0·321. This slight difference is again readily explained by the greater dolichocephaly of the Australian brain. The pre-callosal and post-callosal lengths may be similarly expressed as indices in terms of the total brain length. Duckworth has used a similar comparison. His figures show considerable individual variation. The pre-callosal index in three cases is between 18 and 19, while in one case it is 13·6. The present series is quite self-consistent and gives an average value of 20·24, somewhat higher than Duckworth's values. The values for the Kappers' series I have calculated from his chart, and the average value is 18·5. The post-callosal index for the Australian in my series is 33·78. For Duckworth's series, three hemispheres are 33. For a Dutch dolichocephalic the average is about 30. Again we are dealing with an expression of the extreme dolichocephaly of the Australian brain.

Thus from a comparison of the indices we arrive at the general conclusion that the variations in the indices of the Australian brain present no peculiar features, and the differences that exist between it and the European dolichocephalic brain are all understandable in terms of the greater dolichocephaly of the Australian.

Table of Indices of Aboriginal Brains.

Origin of brain	L.B. index brain	Height index	Oc-cipital index	Tem-poral index	Frontal height index	Frontal length index	Cal-losum height	Stem angle
Full-blood Aborigine								
(1) R. hemisphere	72·83	0·521	1·123	0·128	1·878	0·235	0·319	108°
L. hemisphere	—	0·510	1·014	0·134	1·852	0·241	0·319	—
(2) R. hemisphere	71·68	0·500	1·093	0·107	1·742	0·250	0·352	107°
L. hemisphere	—	0·522	1·142	0·110	1·702	0·272	0·333	—
(3) R. hemisphere	75·3	0·481	0·846	0·152	1·552	0·277	0·267	105°
L. hemisphere	—	0·477	0·833	0·132	1·617	0·250	0·271	—
Average	73·27	0·502	1·008	0·127	1·728	0·254	0·310	106·6°

	Precallosal index	Postcallosal index
(1)	L. =20·56	L. =32·6
	R. =19·3	R. =33·14
(2)	L. =20·6	L. =36·0
	R. =20·0	R. =32·14
(3)	L. =22·03	L. =33·8
	R. =19·0	R. =35·0

PERCENTAGE OF GREY MATTER PER HEMISPHERE

The final investigations made on these Australian brains concerned themselves with the relative proportions of the grey and white matter per hemisphere, and to the brain as a whole. For this purpose we used the method introduced by Kappers. In his paper there is a discussion of the various methods that have been used for this purpose. At first I was disposed to believe that the method would only give a poor approximation to the real values, but after trying it out I was persuaded that even when different people carried out the necessary manipulations the degree of agreement between the results suggested that the method was sufficiently valuable to be applied to these brains.

The brain was hardened in 10 per cent. formalin and weighed. The cerebellum was then removed and the hemispheres divided in the sagittal plane, and the parts weighed. By means of Reichert's macrotome the hemispheres were cut in 2 mm. sections, and then by means of a mounted safety razor blade the cortex was separated from the rest of the hemisphere. The separation was made easy by first staining the cortex with 1 in 1000 nigrosine for 3 hours. Since the moisture absorbed by the brain when cut into many small pieces is greater than that contained originally in the brain, drying must be allowed to proceed until the final weight of the cortex and white matter is the same as that of the undivided hemispheres. There is probably an exaggeration of the amount of cortex present, for in cutting the cortex from the white matter there is a tendency to preserve the cortex at the expense of the white matter, The results are as follows:

Right Hemispheres.

Brain	Total brain weight (gm.)	Weight of hemisph. (gm.)	Weight of cortex (gm.)	Weight of white matter (gm.)	% cort. per hem.	% cort. total br. wt.
1	1138·0	481·5	224·7	256·8	46·66	19·74
2	1123·0	495·0	240·0	256·0	48·5	21·04
3	1044·6	442·1	242·1	200·0	54·76	21·26

Left Hemispheres.

Brain	Total brain weight (gm.)	Weight of hemisph. (gm.)	Weight of cortex (gm.)	Weight of white matter (gm.)	% cort. per hem.	% cort. total br. wt.
1	1138·0	482·5	240·0	242·5	49·74	21·23
2	1123·9	481·0	227·5	253·0	47·36	20·2
3	1044·6	448·0	238·0	210·0	53·2	22·8

The average of the cortical percentage per hemisphere in all the specimens is 50·04 per cent. This might be compared with that found by Kappers for the Dutch brains 50·65 per cent., and for Chinese brains 50·45 per cent. The slight differences present may well be explained by the errors of the method. Thus it is concluded that the ratio of white and grey matter in the aboriginal brain is in the same proportion as in other human brains. The percentage weight of the grey matter to the total brain weight is also in close agreement with the figures supplied by Kappers.

The only other point that impresses one in these figures is the lowness of the value of the weight of the whole brain and the weight of each hemisphere. The highest brain weight is obtained in Brain 1, which on other grounds was considered the simplest of the three. Though the brain weights given here can be matched easily among European brains, yet it is to be observed that three random aboriginal brains gave an average total brain weight of 1095 gm., and the brains tabled by Kappers contain one of the same order as the aboriginal brains, while the others are much higher, the average being nearly 1268, a difference of 150 gm. Thus, by the method employed, no significant difference is disclosed in the amount of white matter and grey matter in the Australian brain from that found in other races.

A comparison of the hemispheres of the two sides reveals no constant difference between them. Sometimes the left and sometimes the right has the higher percentage of grey matter. This again is in agreement with the results obtained by Kappers.

The general result of this enquiry, employing a comparison of fissural pattern, of anthropological indices, and finally the ratio of cortex per hemisphere, is to bring the Australian brain into agreement with other human brains. These observations offer no ground for supposing that the aboriginal brain discloses any peculiar simian features, or that it resembles microcephalic brains of European origin, or that it retains any special features of the foetal human brain. Anthropological differences reside in the extreme dolichocephaly of the aboriginal brain. The distinguishing features of the Australian brain are the presence of the following characters together: it is a small brain; it is extremely dolichocephalic, the insula tends to be exposed, and it retains primitive features in the organisation of the striate area. No other characters have been disclosed by this enquiry.

SUMMARY

1. The fissural pattern of the aboriginal brain shows two features which distinguish it from European brains in general: (*a*) the retention of a paracalcarine fissure and a sulcus lunatus; (*b*) a tendency for the insula to be exposed. The general disposition of the remaining fissures and their variations are best accounted for by the extreme dolichocephaly of the brain.

2. Variations from the measurements of European brains are adequately accounted for by the extreme dolichocephaly. The proportions of the various regions of the brain are of the same order as in European brains.

3. The proportion of grey matter per hemisphere is the same as in European brains.

4. The total brain weight and also the weight of the hemispheres appear to be smaller than in European brains.

5. There are no significant differences between the right and left hemispheres.

REFERENCES

DUCKWORTH, W. L. H. (1908). "On the brains of aboriginal natives of Australia in the Anatomy School, Cambridge University." Parts I, II and III. *Journ. of Anat.* vol. XLII.

FLASHMAN, J. F. (1908). *The Morphology of the Brain of the Australian Aboriginal. Reports from the Pathological Laboratory of the Lunacy Department, New South Wales Govt.* Vol. I, pt III.

KAPPERS, C. U. ARIENS (1926). "Indices for the Anthropology of the Brain Applied to Chinese, Dolicho- and Brachycephalic Dutch, Foetuses and Neonati." *Koninklijke Akademie van Wetenschappen te Amsterdam, Proceedings*, vol. XXX, No. 1.

—— (1925). "The Relative Weight of the Brain-cortex in Human Races and in some Animals and the Asymmetry of the Hemispheres." *Koninklijke Akademie van Wetenschappen te Amsterdam, Proceedings*, vol. XXVIII, Nos. 8 and 9.

SHELLSHEAR, J. L. (1926). "The Occipital Lobe in the Brain of the Chinese, with Special Reference to the Sulcus Lunatus." *Journ. Anat.* vol. LXI.

SMITH, G. ELLIOT (1904). "The Morphology of the Occipital Region of the Cerebral Hemisphere in Man and the Apes." *Anat. Anzeiger*, Bd. XXIV.