AN ANATOMICAL STUDY OF THE HUMAN BRAIN

A dissertation submitted to the Faculty of the College Department of St. Meinrad Seminary in partial fulfilment of the requirements for a Bachelor of Science Degree.

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INTRODUCTION

The human brain, as defined in Morris' Human Anatomy, is the greatly enlarged and modified portion of the central nervous system that is enclosed in the cranial cavity. In order to safeguard the delicate nerve endings of the brain, it is protected by the hard bones of the skull, and is further surrounded by three meningeal membranes, the pia mater, the dura mater, and the arachnoid layer. The brain nearly fills the cranial cavity. There are five divisions to the adult brain; 1) medulla oblongata, 2) cerebellum and pons, 3) midbrain, 4) between brain, 5) cerebral hemispheres.

History:

Down through the centuries, the overall aspect of the brain has been observed and studied extensively. It has also been a source for accurate illustrations by such men as Leonardo DaVinci,[1.] and Vesalius.[2.] A study of the basic structures of the pallium is fundamental for neurological studies. The literature for experimental work on the pallium is not extensive.

Since 1543, when Andreas Vesalius issued his De Humani Corporis Fabrica, which contained illustrations of cross sections of the brain, the anatomists have used these methods

of cross sectioning to show relations between various structures. Leonardo DaVinci, in 1510, made such detailed drawings of the human torso, that some are still used today. In the following centuries, notably the 16th, 17th, and 18th, famous anatomists such as Vesling, deGraaf, von Haller, Scarpa, Placentius, and others, used the cross section to supplement their studies. In modern times, one of the great classics is Dr. Wilhem Braune's Topographisch-anatomischer Atlas; nach Durchschnitten an gefrornen Cadevern, which showed the frontal sections in colored lithograph plates. The twentieth century shows marked progress because of the advanced processes, one of which is to freeze the cadaver to insure precise cuttings. The Cross Section Anatomy, by Eycleshymer and Shoemaker in 1911, gives details of all the historical progress in methods of preparing cadavers for cutting. In 1948, Truex and Kellner made a sectional study of the head entitled Detailed Atlas of the Head and Neck. Dr. Kampmeier's Frontal Sectional Anatomy of the Head and Neck, which was used as a guide for the present study, gives an extensive bibliography of the history, and experiments of frontal section cuttings.[3.]

Present Study:

The present study deals with the anatomy of the human brain from two views; the first, a study of the cerebral

cortex, and the second, a detailed study of the frontal sections of the brain.

Taking the first division of this thesis, the cerebral cortex, or pallium, we can divide it into five parts, each of which corresponds to a certain view of the pallium. These views are; top view, basal view, lateral view, ventral or frontal view, and posterior or occipital view. Observations made from all these views were accurately portrayed and labeled. The basic structures included are the fissures, or deeper and more constant furrows; the sulci, or shallower and more variable furrows; the gyri, or convolutions of the cerebral cortex; and the lobes, or external surface area.

The second division deals with accurate measurements of the frontal sections of the brain, with emphasis on the fissures, and internal distribution of white and gray matter. White matter is composed of those portions of the central nervous system which contain the myelin sheaths, or the nerve fibers. Gray matter is composed of those portions of the central nervous system, in which the predominant feature is the cell body of the neuron. The difference between white and gray matter is striking. Unlike the white matter, which needs little food and nourishment from blood vessels, the gray matter is composed of many blood vessels, dendrites, and neuroglia. The convolutions that make up the

internal fissures are surrounded entirely by gray matter, mainly because these fissures contain larger blood vessels, which enable them to transport blood to the sensitive gray matter. The white matter has no fissures.

MATERIAL AND METHODS

The brain used for this study of the cerebral cortex cannot be traced to a specific source. The dry weight is 1076 grams, and its specific gravity is 1.22. A study including a general description and observations of the external surface of the pallium was done on this brain.

In addition, a sectional study, a precision study of internal structures, was undertaken on another brain. Measurements were made with a caliper to insure maximum accuracy. The brain used for this part of the study was obtained from the Psychology Department of the Catholic University of America.

In observing the pallium, a rough measurement of the basic dimensions, namely the length, width, and depth, was made with a ruler and large caliper. This method was found to be unsatisfactory for accuracy. Photographs of the brain were taken, and, using as rough estimate the first measurement, the photos were made to actual size.

The five sections were traced onto stiff posterpaper, and labeled.

The cross sections were made of two separate hemispheres of the brain, right and left. Parts of the left hemisphere were missing, however, enough was present to justify an accurate measurement. The hemispheres were measured, and their thicknesses were recorded in a separate median view. The sections were numbered from the dorsal, ventrad, so that easy identification would be possible. The right hemisphere was measured in three out of seven sections, and the left hemisphere in three out of five. As for the individual sections, the dorsal and ventral sides were marked; the measuring and cross measuring being done with a small caliper. The gray and white matter was observed, and the fissures and ventricles noted, but not labeled. Each individual section was calibrated. Drawings were made on stiff posterpaper, and inked with India ink.

An entire cerebellum was measured from anterior side to posterior side, but not from the lateral view, because of the distortions of the cerebellum in this particular specimen. The fissures were not noted, but the general pattern of the fissures was marked with arrows.

RESULTS AND DISCUSSION

Weight:

The weight of this particular brain, in comparison with an average brain, is a bit below average. Average weight for males is 1360 grams, and for females 1250 grams. The average brain weight for humans lies between 1100 to 1700 grams, varying with height, weight, and bulk of tissues. Since the size of the cranium is only a general indication of the size or volume of the brain, it follows that two people with equal cranial capacity might have differences in brain weight. Minimum weight of the adult brain is 950 to 1000 grams, for normal intelligence. The relation of brain weight to size is relative, depending on the structure of the skeleton, defects, disease; but it can generally be said that the brains of higher intelligence are heavier.[4.] This leads to the assumption that this particular specimen could have come from a female of somewhat low mental abilities.

General Observations On The Cerebral Cortex:

In many aspects, the specimen studied corresponds closely with the anatomical evidence found in the literature in the field.[5.] One aspect to consider would be the top view of the pallium of this particular specimen. In comparison with a nornal brain, it shows many basic similarities. Location of various lobes, the central sulcus, and other

prominent gyri and sulci are easily found. As can be seen in Figure 1, these correspond with observations made in other studies, although it is difficult to locate them due to the presence of membranes that cover the pallium of this specimen.[6] In associating and comparing the different structures, the more obvious, such as the frontal and occipital poles were readily observed. The lobes, sulci, and gyri, were located after comparison. The smaller structures, which were obscure on the photographs, were not identified due to the conditions of the specimen.

The basal view, Figure 2, shows all lobe areas clearly. The sulci and gyri are more easily identified and correspond to the observations of other workers.[7] Both gyrus and sulcus hippocampus, and temporal-inferior gyrus and sulcus, in this specimen, follow closely observations reported by other workers.[8] Olfactory bulbs, optic chiasma, and optic nerve are evident and labeled in Figure 2.

It is difficult, in the right lateral view, Figure 3, to follow the sulci to any definite structure, due to the many blood vessels, which ramify the surface of the pallium. The general fissures, such as the lateral fissure, can be identified. In the overall view, the brain pallium seems to consist of many discrete areas, as can be seen on the drawing of the specimen. The lengthwise folds of the pallium are not

detected as a continuous gyrus.

Both the frontal view, Figure 4, and the dorsal view, Figure 5, of this specimen present the same difficulties encountered in the lateral view.

Defects:

The specimen observed was abnormal in several anatomical aspects. As can be seen in Figure 6, the longitudinal fissure of the pallium is quite abnormal, leaning to the right hemisphere very noticeably. Instead of the fissure being perpendicular from the corpus callosum to the surface of the pallium, in this specimen, the fissure leans to the right. See Figure 10. The left hemisphere is somewhat larger than the right hemisphere in volume. This condition could have resulted from changes brought on by storage. This is very unlikely, however, because of the condition of the cerebellum. The cerebellum conforms strictly to reported observations.[9] It would seem that this disproportion of volume could not have occured through storage, but is rather one of abnormal development.

General Observations Of The Frontal Sections:

Observations of the cross sections of both hemispheres reveal evident differentiation of gray from white matter. The white matter is more abundant, usually centering about

the center of the individual hemisphere. Gray matter lines all fissures to about a quarter-inch depth. The corpus callosum was severed on this specimen, but is visible in most sectional drawings.

Right Hemisphere:

Section Number 2, Figure 12, is 7 cm. in height on the dorsal side and 8 cm. on the ventral side; it is 1.2 cm. on the posterior surface and 2.2 cm. wide on the anterior surface. An evident structure on the dorsal, but not the ventral view, is the existence of a sulcus, surrounded by gray matter, in the middle of a mass of white matter. It is 1.9 cm. in length. There is more white matter on the ventral side. The dorsal side has a large mass of gray matter against its lateral wall. This could be explained on the basis of the angle at which the brain was cut.

Section Number 5, Figure 13, is 8.5 cm. high on the dorsal side, and 8.5 cm. high on its ventral side. It is 1.8 cm. in width on the posterior side, and 1.8 cm. in width on the anterior side. This hemispheric cross section approximates very closely structures noted by Sobotta-Uhlenhuth. There is much white matter in both dorsal and ventral surfaces. The ventral surface has a greater mass of gray matter against its lateral wall than does the dorsal.

It is evident where the corpus callosum is situated. In both sections the cerebral lateral fissure is plainly evident. The nucleus lentiformis is visible.

Section Number 7, Figure 14, is 8 cm. in height on its dorsal side and tapers to a blunt end on the ventral side. At its widest point, the dorsal side is 4.4 cm. in width. The proportions of the white matter to gray matter is greater in this section, but not as great as in Section 5, Figure 13. The nucleus lentiformis is evident on the ventral side, which is the only side visible from a frontal view. The lateral cerebral fissure is evident. This view conforms with evidence of other authors.[10.]

Left Hemisphere:

In the left hemsiphere, Section Number 1, Figure 16, is 7.5 cm. in height on its ventral side. The dorsal side tapers off to a round end. The greatest width of the lateral view is 5.3 cm. The white matter greatly outproportions the gray matter on this plate. The fissures are more numerous and smaller on this cross section than in the Section Number 2, Figure 12, of the right hemisphere. A ventricle is evident in the middle of the white matter, and lies dorsally ventrad, and so, it is still small in this plate.

The Number 3 Section, Figure 17, is 7.1 cm. in height on the dorsal side, and 7.4 cm. on the ventral side. It is

.9 cm. in width at the posterior surface, and 1.1 cm. in width on its anterior surface. This section shows a predominance of white over gray matter. The gray matter is a few tenths of a centimeter greater than in the previous section.

Section Number 5, Figure 18, is 8 cm. high on the dorsal side and 8 cm. high on its ventral side. It is .8 cm. in width on both posterior and anterior surfaces. This section is irregular because it is located in the temporal lobe area and thus is almost cut in two parts on the ventral side by the cerebral lateral fissure. The complete break is not seen on the dorsal side. There are only a few centimeters of brain tissue attaching both lobes and the rest of the structure. Besides this, the ventral side has a peculiar structure located between the corpus callosum and the lateral wall. It corresponds to the nucleus lentiformis as reported in Sobotta-Uhlenhuth. The white matter is not as prominent on the ventral surface. The gray matter here is twice as thick as the gray matter in Section 1, Figure 16. On the dorsal side, the gray matter does not seem to be as thick as the ventral side.

SUMMARY

The dry weight of this particular specimen was below the average weight of a normal human brain. It is assumed that it came from a female of somewhat low mental ability.

Overall observations on this specimen showed basic similarities with a normal human brain. In several anatomical aspects this specimen was abnormal. It is thought that the resulting disproportion of volume between the two hemispheres could have resulted from abnormal development of the structures involved.

Anatomically the sectional study of the hemispheres revealed the fundamental pattern. The fissures studied were in depth and position in accord with the literature. The relative relation of gray and white matter, as can be seen in the sections, followed the normal pattern. It was observed that in this specimen in the right hemisphere the amount of gray matter became greater dorsally ventrad. In the left hemisphere the same observation was noted with the gray matter increasing in volume dorsally ventrad.

FOOTNOTES

1. Richard Friedenthal, Leonardo DaVinci--A Pictorial History, p. 81.

2. J. B. Saunders and Charles D. O'Malley, Andreas Vesalius of Brussels, pp. 144-47.

3. Otto F. Kampmeier, A Frontal Section Anatomy of the Head and Neck, pp. 1-8.

4. J. Parsons Schaeffer, ed., Morris' Human Anatomy, p. 920.

5. M. J. Sobotta and Eduard Uhlenhuth, Atlas of Descriptive Human Anatomy, vol. III, pp. 190-246.

6. Idem, pp. 190-201.

7. Idem, pp. 183, 187, 191.

8. Idem, pp. 183, 187, 191.

9. Idem, pp. 191, 264, 266.

10. Idem, pp. 230, 232, 233, 235, 238.

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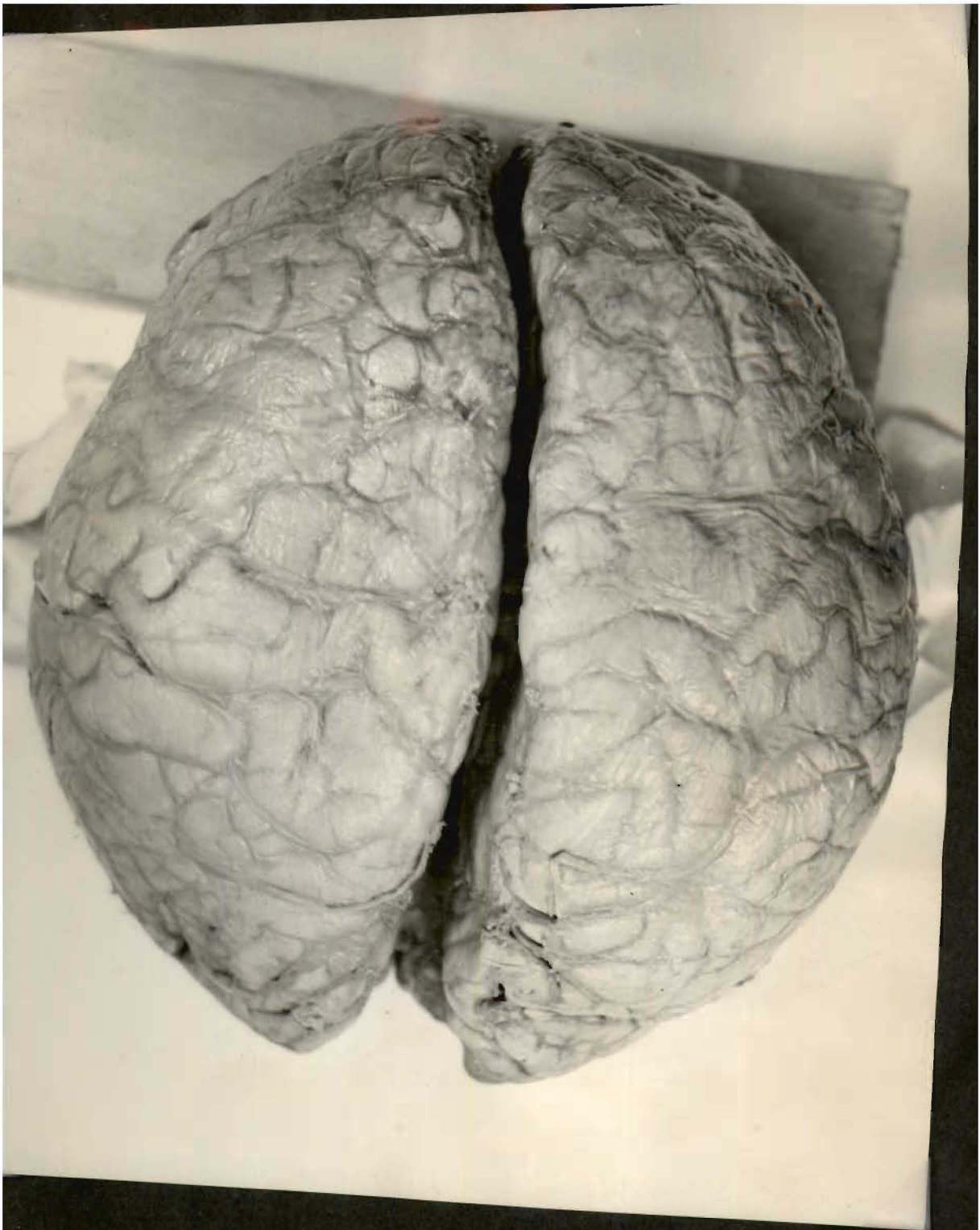

FIGURE 6. TOP VIEW

FIGURE 7. BASAL VIEW

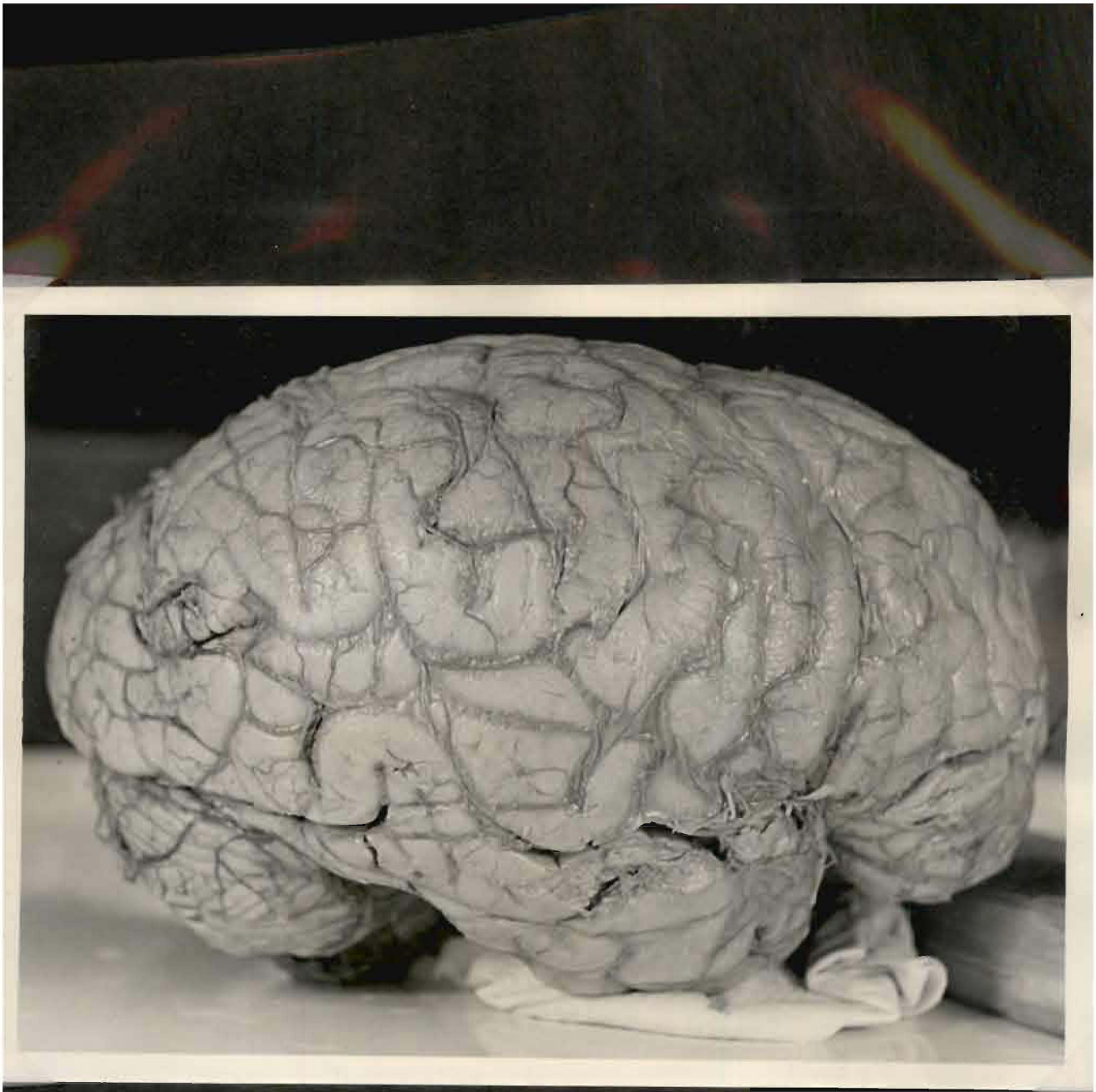

FIGURE 8. RIGHT LATERAL VIEW

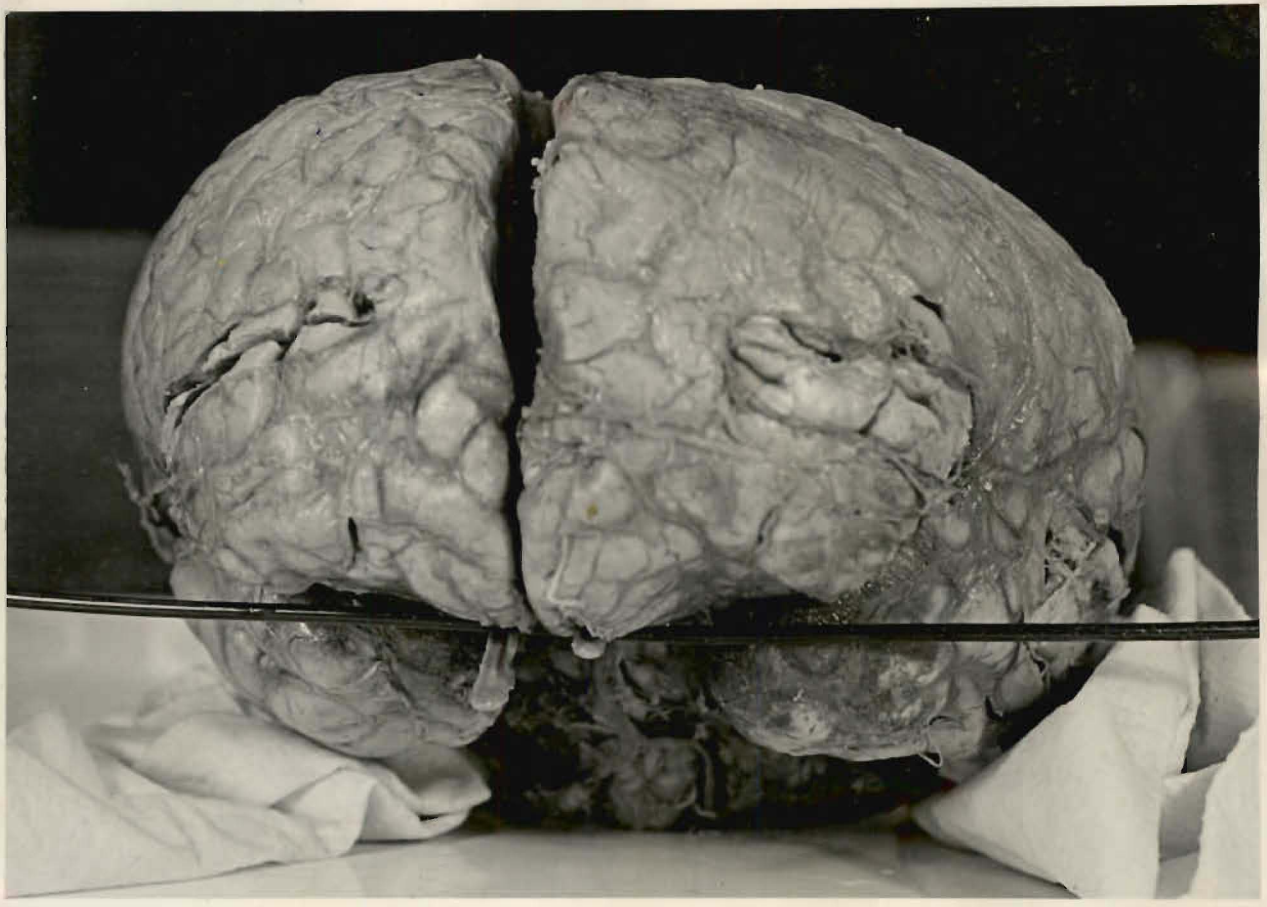

FIGURE 9. FRONTAL VIEW

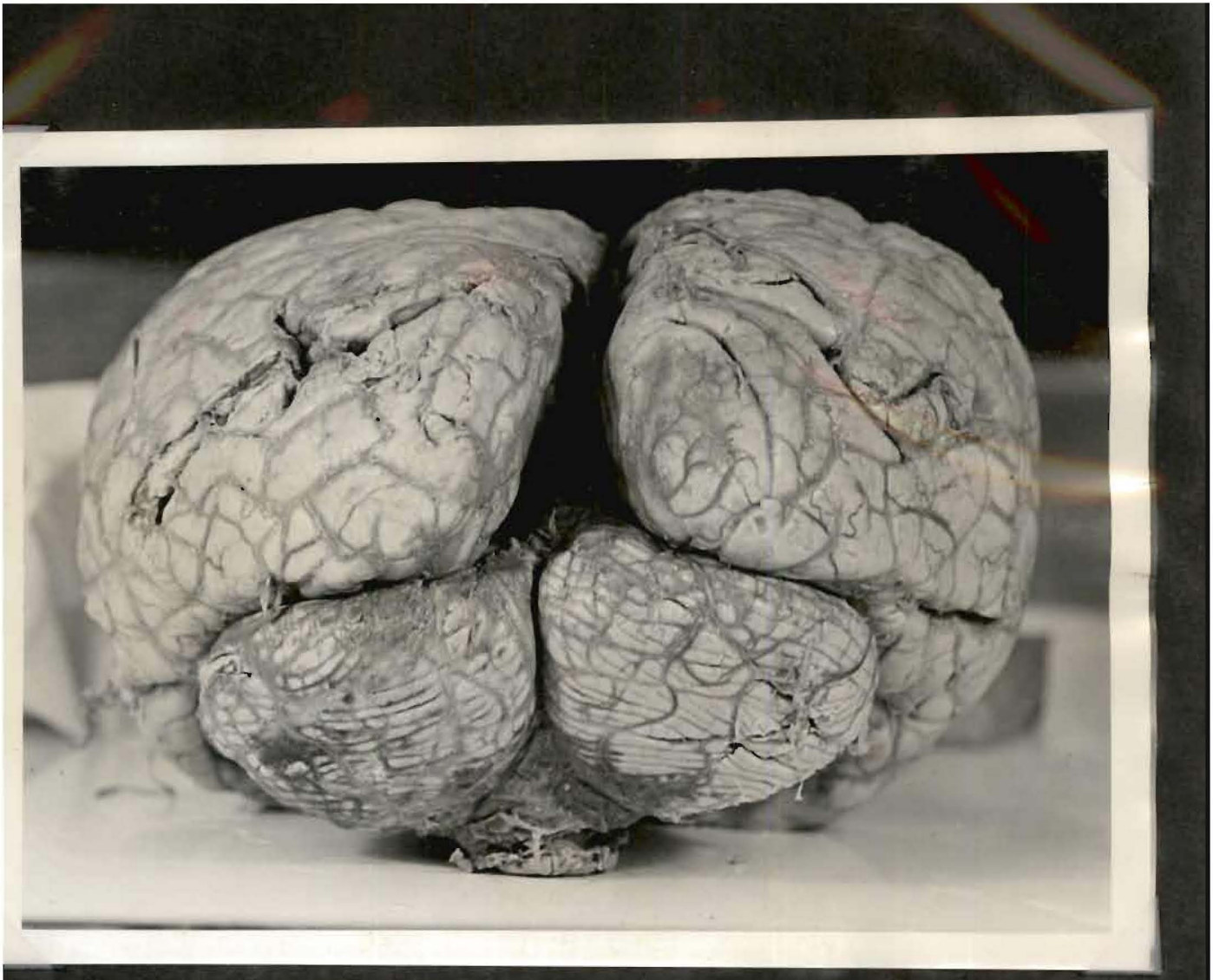

FIGURE 10. OCCIPITAL VIEW