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Anatomy. — “*On the occurrence of a monkey-slit in man.*” By
Dr. C. T. VAN VALKENBURG. (Communicated by Prof. WINKLER).

(Communicated in the meeting of December 28, 1912.)

It has long been known that under some circumstances, in case of disturbances in the development of the central nervous system of man, a slit may occur on the surface of the occipital lobe vividly reminding of the so-called monkey-slit of anthropoides. I communicated an example of this fact in a former paper.¹⁾ The slit then characterized as monkey-slit, answered to the requirement that at least part of its occipital boundary covered convolutions at the bottom of the slit connected with the parital lobe (operculation). ELLIOT SMITH²⁾ has described the brains of many Egyptians in which he very often found (70% of the hemispheres) a *sulcus simialis* sive *lunatus*. BRODMANN³⁾ corroborated this view with the brain of three Javanese. On the other hand ZUCKERKANDL⁴⁾ thinks that the existence of a monkey-slit in man is by no means proved. As a proof he gives a reproduction of some hemispheres in his above-mentioned essay. On these surfaces however — of course specially selected by ZUCKERKANDL — ELLIOT SMITH would doubtlessly diagnose a monkey-slit.

How are these contradictory views to be reconciled. We read in ZUCKERKANDL's paper (l.c.): “Am menschlichen Gehirn soll nur ‘dann von einer Affenspalte die Rede sein, wenn an der Hemisphärenoberfläche beide Ränder der fraglichen Furche mit jenen der Affenspalte am Affengehirn identisch sind. Trifft dies nicht zu, liegt eine Furche vor, welche nur auf einer Seite (hinten) von einem der Grensränder der Affenspalte abgeslossen ist, während der andere (vordere) nicht mehr dem Gyr. angularis sondern einem Bestandteil der Affenspaltengrube (Uebergangswindungen) angehört, dann hat man es nicht mit der typischen Affenspalte zu tun.’”

1) VAN VALKENBURG, Surface and structure of the cortex of a microcephalic idiot. These Proc. XII p. 202.

2) ELLIOT SMITH, Studies on the morphology of the human brain. Records of the Egyptian Government School of medicine. Cairo 1904.

ELLIOT SMITH, The persistence in the human brain of certain features usually supposed to be distinctive of apes. Report of the British Assoc. for the advancement of Science 1904, p. 715.

3) BRODMANN, Beiträge zur histologischen Lokalisation der Grosshirnrinde V. Journ. f. Psych. u. Neurol. Bd. VI. S. 296.

4) ZUCKERKANDL, Ueber die Affenspalte und das Operculum occipit. des menschlichen Gehirns. Obersteiners Arbeiten Bd. XII, S. 207.

ZUCKERKANDL strongly emphasizes a difference between monkey-slit — i.e. the slit between the operculum occipitale and the parietal convolution lying frontally to the operculated transition-convolutions — and the monkey-slit sulcus — i.e. the sulcus lying on the bottom of the sulc. lunatus.

This difference must unconditionally be accepted, and to my knowledge this is done by the majority of authors (BOLK a.o.).

It is however another question whether this difference is really of such a nature that we should be compelled by it for ever to deny the homologisation between a monkey-slit and a very similar sulcus in man. For that similarity is even readily accepted by ZUCKERKANDL, as he admits the occurrence of "Affenspaltresten" in man. ELLIOT SMITH is of opinion that the difference is nothing but a quibble of words. Evidently the matter hinges upon the question: what is in the monkey-slit-complex the cardinal point? We have then the choice between the *slit* — postulating the existence of bottom-convolutions and an operculum covering these — and the sulcus existing on the bottom of the slit, which if there are no bottom-convolutions to be operculated, looks like every other sulcus.

In lower monkeys (platyrrhines) and prosimii¹⁾ a sulcus is found that must doubtlessly be indicated as sulcus lunatus whilst bottom-convolutions, operculum, a proper "monkey-slit"²⁾ may be absent.

This sulcus lies in the brains of these animals transversally — often not reaching the interhemispherical fissure — across part of the latero-dorsal surface of the lob. occipitalis. No other sulcus ends in it; it lies occipital from the sulcus parieto-occipitalis. In some platyrrhines (ateles) the sulc. interparietalis (which, as has been remarked, does not reach the sulc. lunatus) forms a T-shaped extremity, sometimes already indicated in some specimens of lemuridae. I refer those interested in this problem to the report that will be given by Dr. ARIENS KAPPERS in 1913 at the International Congress of Medicine in London: Cerebral localization and the significance of sulci.

Ascending in the range of monkeys we find that the sulc. interparietalis in katarrhines has its distal termination in the s. lunatus. At the same time we find that, at the bottom of the latter, cortical convolutions are hidden; its occipital lip has grown an operculum.

The most developed katarrhines — the anthropoides — usually

¹⁾ ZIEHEN, Ueber die Grosshirnfurchung der Halbaffen Arch. f. Psych. Bd 28 S. 898.

²⁾ KÜKENTHAL u. ZIEHEN, Untersuchungen über die Grosshirnfurchen der Primaten · Jenaische Zeitschr. für Naturwissensch. Bd. 29, S. 1.

For further literature vide ARIENS KAPPERS (l. c.).

show the beginning of apparent return to lower relations, because part of the transition-convolutions (the first) has become superficial. It is however still separated by the sulc. interparietalis from the superficial part of the 2nd transition-convolution. A similar situation was to be found in the microcephalic idiot described by me in a former paper (l. c.). If now moreover the 2nd and 3rd transition-convolutions become superficial i.e. if they pass from the bottom of the monkey-slit to the surface of the lob. parietalis, then of the entire s. simialis-complex there remains only the bottom-sulcus which is then, with regard to its parietal lip, differently limited from what was the case with anthropoides, at least as regards the region of the 2nd and 3rd transition-convolution. This is however not always the case. Also where there is no question of great disturbances of development, as in the above-cited case of mikrocephalia, little hidden convolutions may be found (vide e. g. some drawings in ZUCKERKANDL's paper l. c.). Such brains connect the monkey-slit in a more limited sense -- as it occurs in anthropoides -- with the sulcus lunatus (as with ELLIOT SMITH we best call it) of man. About the frequency of the occurrence of this sulcus in Europeans I cannot fix a percentage on account of my limited material.

In 22 hemispheres of idiots of the Institute for Brain-research I find it 8 times. In the brain of normal individuals it likewise "often" occurs. ELLIOT SMITH fixed already the attention to the brain-photographs of RETZIUS. I could not decide with certainty whether, as it seems to be ELLIOT SMITH's view, there exists any preference in this respect for the left hemisphere.

Notwithstanding all these assertions it is necessary to fix as strongly as possible the diagnosis: sulcus lunatus. One cannot give a definition of it of *absolute* value, i. e. without involving in it the relation to neighbouring sulci. As conditions for accepting a sulcus lunatus I fixed in general the following relations and circumstances:

1. The sulcus in question lies somewhat crescent-shaped (with its concavity caudad) or more transversal, not far from the pole of the occipital lobe;

2. In its lateral part terminates a sulcus, that is often connected with the first temporal sulcus (*sulcus praelunatus*);

3. More or less parallel to it, more towards the front, lies a

sulcus, into which the sulcus interparietalis terminates (sulc. occipitalis transversus);

4. The occipital extremity of the sulcus calcarinus falls (whether bent or not round the mantle-side) behind it, and sometimes extends between two sulci occipitales which are found there (they may be connected V-shaped).

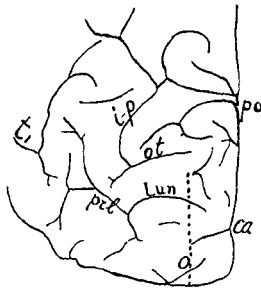


Fig. 1.

Occipital lobe of the idiot *D*, seen from behind. The dotted line indicates the direction of the section according to which fig. 4 has been drawn; for the shortenings vide text.

Fig. 1 represents an occipital lobe (of an idiot) seen from behind on which the above-mentioned desiderata have been most accomplished.

The principal requirements are fulfilled: the situation of the sulci occipitalis transversus (*o.t.*) and calcarinus (*e.a.*) resp. before and behind the sulcus lunatus (*Lun*) is typical. At the former the sulcus interparietalis (*i.p.*) terminates; the sulcus parieto-occipitalis (*po*) cuts frontally from it the medial mantle-side. An indication of a V-shape of the occipital sulci (*o*) between which the sulc. calcarinus points, is extant. The sulcus praelunatus (*pr.l.*) is distinct, but not immediately connected with the sulc. temporalis primus (*t.*). All other hemispheres possessing the sulcus lunatus have a similar appearance. The greatest variation exists in the occipital sulci and the relations of the sulcus praelunatus. All our cases answer to the above-mentioned principal requirements, where a sulcus lunatus was admitted, with only one exception. In the latter case (it regards the cerebrum of an idiot, with a too little frontocaudal diameter; weight of the brain about 1000 grams) the cuneus is very narrow, because the sulcus calcarinus has a strongly dorsal direction. I refer to fig. 2. At the limitation of the second and posterior third part of the cuneus this sulcus splits T-shaped. The inferior branch terminates near the occipital pole, behind the sulcus lunatus, the dorsal branch reaches the medial mantle-side immediately behind the sulcus parieto-occipitalis; consequently not only far before the sulcus lunatus, but even before the sulcus occipitalis transversus. Vide fig. 3.

I come to the conclusion that this branch must indeed be reckoned to the sulcus calcarinus, and is not a cuneus-sulcus

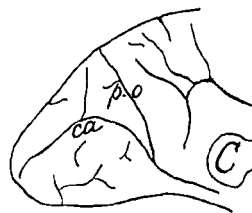


Fig. 2.

Left occipital lobe of the idiot *W*, seen from the medial side.

po = sulc. parieto-occipitalis
ca = sulc. calcarinus
C = corpus callosum (splenium).

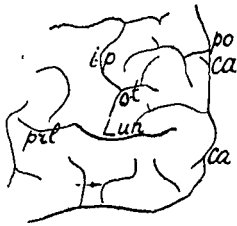


Fig. 3.

The same occipital lobe as fig. 2, seen from behind; shortenings as above.

terminating in the sulcus calcarinus from the fact, that its lips show as distinctly as the other part of the sulcus in question a beautiful stripe of Vicq d'Azyr. When using this argument we have introduced into our reasoning a new element of a microscopical, anatomical, and even, may be, of a physiological nature. Many anatomists indeed regard the region over which the above-mentioned stripe extends as the terminal region of the centripetal, geniculoccipital radiation, the recipient optic cortical-field (Visuosensory: CAMPBELL, BOLTON, MOTT a.o.).

Apart from any physiological function and even from specific projection-combinations we may admit in man as irrefutable, that wheresoever the typical stria Vicq d'Azyr is found, we have to do with an area of a special character, which on account of its peculiar relations (in the greater majority of cases) to the limitations of the sulcus calcarinus, may be characterised as regio calcarina. Area striata (ELLIOT SMITH) area 17 (BRODMANN) and regio calcarina are consequently regarded in man as synonyms. My above mentioned conclusion that in reality the cuneus-sulcus terminating in the sulcus calcarinus must be regarded as a final branch of that sulcus seems consequently not to be a hazardous assertion.

As especially BRODMANN¹⁾ has taught us, the area striata (his area 17) extends in the monkey over the lateral surface of the lob occipitalis (the operculum occipitale) as far as the monkey-slit.

ELLIOT SMITH stated the same fact in his Egyptians, be it over a more narrow strip of the region concerned, and he uses this fact as one of the arguments for homologising his sulc. lunatus with the monkey-slit. This author conceives the connection between histologically-characterised areas and brain-sulci a little schematically: very regularly he admits and represents the latter as limits of the former²⁾. Apart from the fact that after the investigations of BRODMANN, CAMPBELL a. o. his view cannot be maintained in this form, it postulates in the case discussed here a complete homology in the relation between the sulcus lunatus and the area striata in monkey and man. As appears from the phylogenesis of the sulci there is no complete parallelism between the evolution of the sulci and the relative migrations of the special cortical zones.

¹⁾ BRODMANN: Vergleichende Lokalisationslehre der Grosshirnrinde. Leipzig 1909.

²⁾ ELLIOT SMITH: A new topographical survey of the human cerebral cortex. Journ. of Anat. and Physiol. Vol. 41.

ZIEHEN¹⁾ called already attention to the comparative slowness, with which in the range of development of mammals sulci change their places.

In the report that he intends to give (l.c.), ARIËNS KAPPERS comes on other grounds to the same but more developed conclusion: sulci are more conservative than the neighbouring cortical zônes.

Where we see in man the area striata extending as far as the sulcus lunatus — if the latter is extant — we may see in it a very welcome affirmation of the similarity between sulcus lunatus and monkey-slit, ascertained by other methods (morphologically). It can however not be a point of issue for proving a homology — in the way as ELLIOT SMITH regarded this fact.

As far as the extension of the area striata can be mapped out macroscopically (with the help of the magnifying glass) (ELLIOT SMITH'S investigation was made in this way) the material of the Brain-Institute does not offer uniform indications. It seems that the area striata is not always dorsolaterally limited by the sulc. lunatus; this limitation is likewise not a sharp one in this sense, that sulcus and area must join each other without any intervening space (in this respect our material corresponds with BRODMANN'S Javanese). The type of the

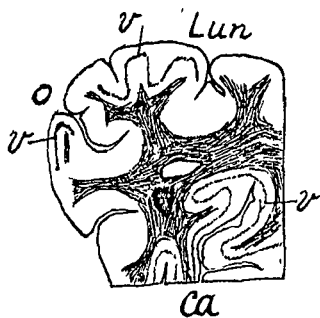


Fig. 4.

v = stria Vicq d'Azyr; other shortenings as above.

Sagittal section through the occipital lobe of the idiot *D.* (vide fig. 1).

In man (our material) this sulcus shows a very different depth; in this respect likewise it seems to show all the transitions between the anthropoid-like state and its total disappearance from the surface of the brain; its extremities (medial and lateral) are most undeeep.

It seems as if first the hidden convolutions, afterwards their bottom is brought to the periphery; the cortex is "smoothed".

The immediate connexion between area striata and sulc lunatus,

¹⁾ ZIEHEN: Ein Beitrag zur Lehre von den Beziehungen zwischen Lage und Function im Bereich der motorischen Region der Grosshirnrinde, mit specieller Rücksicht auf das Rindenfeld des Orbicularis oculi. Arch. f. Physiologie 1899, S. 173.

shown by ELLIOT SMITH in his Egyptians — also distinctly visible in fig. 4 — needs not exist in the European who possesses this sulcus. But it is even impossible — at all events in the material I had to dispose of — in cases where a sulcus lunatus is extant always to ascertain a greater extension of the area striata on the lateral surface of the brain, than in cases where no vestige of the above mentioned sulcus is to be found. Of course there is no longer question of a limitation in the sense of SMITH; it is an illustration of the conservatism of sulci we spoke of above, even of one that is destined to disappear.¹⁾

I have asked myself if there was any connection between the existence of a sulcus lunatus on the lateral cortical surface and the extension of the area striata at the medial hemisphere-wall, in so far as the latter in general is connected with — is dependent upon — the direction and the modus of ramification of the sulcus calcarinus. No regularity at all could be ascertained in this respect. A sulcus lunatus can be found with all sorts of s. calcar. I gave already examples of two forms.

I can add as a third, extreme, form a case where sulcus calcarinus and sulcus parietooccipitalis are nowhere connected, where a superficial cuneo-limbic transition-convolution exists at the point of the cuneus, exactly as it is found — almost always — in anthropoids.

The sulc. lunatus that was here very evident, showed *all* the above mentioned characteristics. A more or less “anthropoid” condition of the cuneus, caused by variations in the direction of the sulcus calcarinus does however, as it seems, not always hold connection with the existence of a sulcus lunatus.

In general the existence of a sulcus lunatus is by no means a *proof* of imperfect development of the brain in which it is found. In normal Europeans it is decidedly frequently met with, as ELLIOT SMITH concluded already from the drawings of others. The examples shown by me were taken from idiots, because I found in a comparatively little material such strong variations at the medial occipital surface, each time with distinct sulcus lunatus on the lateral one. It seems probable that defective development may often be the cause of these deviations in the direction of sulci and convolutions, but with regard to the many variations in normal brains it cannot be proved.

Whether and how — in a definite case — the existence of the sulcus lunatus is influenced by such a “defective development” is a phenomenon that lies completely beyond the field of our observation.

¹⁾ In a case of Anophtalmos there existed a beautiful monkey-slit: the area striata at the medial brain-surface scarcely reached the occipital pole: calcarina extension normal.