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SECTIONAL BRAIN STUDY

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Abstract. *Brain maturation studies typically examine relationships linking a single morphometric feature with aspects of cognition, behavior, age, or other demographic characteristics. However, the coordinated spatiotemporal arrangement of morphological features across development and their associations with behavior are unclear. Here, we examine covariation across multiple cortical features (cortical thickness [CT], surface area [SA], local gyrification index [GI], and mean curvature [MC]) using magnetic resonance images from the long-running National Institute of Mental Health developmental cohort (ages 5-25). Neuroanatomical covariance was examined using non-negative matrix factorization (NMF), which decomposes covariance resulting in a parts-based representation. Cross-sectionally, we identified six components of covariation which demonstrate differential contributions of CT, GI, and SA in hetero- vs. unimodal areas. We sought to use this technique longitudinally to examine covariance in rates of change, which highlighted a preserved SA in unimodal areas and changes in CT and GI in heteromodal areas. Using behavioral partial least squares (PLS), we identified a single latent variable (LV; 96 % covariance explained) that recapitulated patterns of reduced CT, GI, and SA that are generally related to older age, with limited contributions of IQ and SES. Longitudinally, PLS revealed three LVs that demonstrated a nuanced developmental pattern that highlighted a higher rate of maturational change in SA and CT in higher IQ and SES females. This novel characterization of brain maturation provides an important understanding of the interdependencies between morphological measures, their coordinated development, and their relationship to biological sex, cognitive ability, and the resources of the local environment.*

Keywords: *virchow method, Flexig, Fischer, Pitre, Ostertag, Sveshnikov, Popov methods.*

Relevance. For the completeness and effectiveness of brain research, it is important choosing the right way to cut it. The cuts must be made in such a way that they maximally satisfied all the requirements allowing the expert to cover the detected changes as widely as possible and would be suitable for seizure material for histological examination and high-quality photographic documentation. In practice, brain research is carried out in various ways and methods, depending on the characteristics of a particular case**.**

The purpose of study. The complex anatomy of the cortical sheet is best characterized using multiple morphometric characteristics. We expanded on recent developments in matrix factorization to identify spatial patterns of covariance across the cortical sheet. Using a large, well-characterized dataset, we examined the differential contributions of neuroanatomical features to cortical covariation in a single analytical framework using both cross-sectional and longitudinal data. We identified dominant modes of covariance between cortical morphometric features and their coordinated pattern of change, demonstrating sexually differentiated patterns and a strong association with variability in age, socioeconomic status, and cognitive ability. This novel characterization of cortical morphometry provides an important understanding of the interdependencies between neuroanatomical measures in the brain and behavioral development context.

Materials and methods. Virchow method (“little book”)In forensic medical practice this well-known old method of cutting the brain. However, at present this method cannot satisfy the increased requirements for brain research and has a number of significant disadvantages

 after the incisions the brain becomes unsuitable for further research and photography;

 if there was any omission during the primary research, then it is practically impossible to fill it out;

 the cut brain, already on the dissecting table, quickly loses its shape, and after fixation in formalin it becomes even more deformed;

 it is very difficult to assess the anatomical and topographical relationships of the injury focus;

 parts of the brain that are important in the pathology of injury (thalamus, hypothalamic region) become unsuitable for visual inspection;

 this method, by disturbing the relationship between the parts of the brain and its longitudinal axis, excludes the possibility of diagnosing asymmetry of the sides of the hemispheres. Based on this, the use of this method should be avoided in cases of traumatic brain injury or suspicion of it.

Flexig horizontal slice method

For an autopsy using this method, the extracted brain is placed on the lower surface and the frontal lobes are turned to the right of the researcher, holding it with the left hand, an oblique cut is made with a large sectioning or brain knife in a horizontal plane from the frontal lobes at a height of approximately 4 cm from the bottom in such a way that it passes directly under the corpus callosum, at the level of the middle of the temporal lobes. Next, the cutting plane is deflected upward and lead to the upper part of the occipital lobes. The separated upper part is laid with convolutions downwards and both parts of the brain are examined (central nuclei, lateral ventricles, cortex and white matter). The study of the brain can be continued using a series of transverse sections of the upper and lower parts of the cerebral hemispheres. In addition, this method is advisable where it is necessary to preserve the circle of Willis with the vessels extending from it. However, the method also has significant disadvantages:

 this section allows you to view the brain at only one level: the cortex, white substance, subcortical nodes and part of the ventricular system;

 for a more detailed examination of the brain, the researcher is forced to crush the brain into small fragments using additional perpendicular cuts, which, as with the Virchow method, is very difficult to restore any anatomical-topographic relationships. Therefore, this method is also not very acceptable and can only be applied in some cases.

Fischer method

The extracted brain is placed on the preparation table of the lower surface up, and the frontal lobes to the right of the researcher and produce seven frontal cuts:

1) directly posterior to the olfactory bulbs;

2) directly in front of the optic chiasm;

3) through the mastoid bodies (mamillary, or titular bodies - an outdated term);

4) at the anterior edge of the pons (varoliev) of the brain;

5) through the middle of the pons;

6) at the beginning of the medulla oblongata;

7) through the middle of the olives of the medulla oblongata

Pitre's slice method

They are a variant of the previous method; they first involve cutting off the brainstem along with the cerebellum, and then carrying out six frontal incisions, while the brain is placed with its lower surface on the table, with the frontal lobes to the right of the dissecting person:

1) 5 cm anteriorly and parallel to the central (Rolandic) groove;

2) through the posterior ends of the frontal gyri;

3) through the precentral gyri;

4) through the postcentral gyri;

5) through both parietal lobes;

6) anterior to the parieto-occipital sulcus.

The brainstem and cerebellum are examined separately in transverse sections taken from the inferior surface. The weakness of the Pitre method is that the guidelines for the cuts are convolutions of the superior lateral surface of the cerebral hemispheres without attachment to the anatomical formations of the lower surface of the hemispheres. Meanwhile, orientation precisely according to these formations is the most rational, since it allows achieve a strict transverse section of both the cerebral hemispheres and the brainstem brain.

Ostertag method

Ostertag proposed a method according to which the entire brain, including the diencephalic region is dissected with parallel incisions made transversely to the longitudinal axis of its stem section. This method does not take into account the longitudinal axis of the cerebral hemispheres. Eventually the cerebrum is cut obliquely.

Sveshnikov method

It is used when dislocation changes are suspected on the part of brain. After horizontal cutting of the skull bones, the hard shell is cut circularly along the line of the skull cut and twice in the sagittal plane along longitudinal fissure of the brain from the side of each hemisphere in such a way that the falx the cerebrum remains intact, and the dura mater in the form of two free flaps are removed. Then the hemispheres are spread apart and examined the lower edge of the sickle, then it is crossed in the area of the cockscomb and retracted back. Autopsy of the brain is performed with a flat horizontal incision along the cut line of the skull, removing the “upper part” of the hemispheres, and on the spot, before removing the brain, the state of its structures and their displacement relative to the sagittal plane are assessed. The remaining part of the brain is then removed for examination.

Popov's method

Allows you to examine the ventricular system, while maintaining the possibility of subsequent study of the brain in frontal sections: the brain is placed on the preparation table with the base up, the frontal lobes away from you. A scalpel is used vertical midline incision through the optic chiasm, gray tubercle, between the mastoid bodies. In the depths of the third ventricle, the intertubercular junction is crossed. The lateral walls of the third ventricle are carefully retracted to the sides and the incision continues towards the brain stem. Moving the knife in the direction toward themselves and slightly downward, they dissect the pons and medulla oblongata, including the ventral wall of the aqueduct and the fourth ventricle. Next, the anterior and inferior horns of the lateral ventricles are dissected from the middle of the original median incision is forward and outward, bending around the visual tuberosities from the inside. Opening posterior horns are produced similarly along arched lines directed backwards and laterally. Examination of the ventricles is important. Unfortunately, in expert practice it is not Due attention is always paid to the study of the ventricles of the brain and their choroid plexuses. Meanwhile, the source of subarachnoid-ventricular hemorrhages can be arteriovenous aneurysms and vascular tumors in the form a bundle or conglomerate of dilated thin-walled vessels in the region of the ventricles brain.

Researches and discussions. When examining bodily injuries, a forensic medical expert must determine the duration of their occurrence. The solution to this issue is usually based on an assessment of the body's response to trauma The nature and severity of such changes depend on many factors, which creates significant difficulties in assessing them. It is known that to evaluate reactive changes in relation to their timing occurrence should be very careful. This is explained, first of all, by the peculiarities of the course of the traumatic process in various tissues, structures, organs, under various conditions of the body at the time of injury (stress, alcohol intoxication, illness) and after it (hypothermia, anemia, craniocerebral injury, etc.). Some post-traumatic processes occur differently in children and people old age. Affect the rate of development of the post-traumatic process and medical procedures performed in a hospital setting. In cases of TBI, the presence of the brain in a closed cavity also affects the rate reactive processes, it is noted that a delay in reparative processes is possible for many hours and even several days. For this reason, the available scientific data on the connection between morphological changes and the duration of the post-traumatic period can be used in this work only as indicative ones. Duly approved methodological recommendations, medical technologies for determining the duration of the post-traumatic period according to the morphology of the entire variety of intracranial changes is currently not available.

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