LOUIS BOLK INSTITUTE

Anatomy

Morphological Anatomy from a Phenomenological Point of View

Guus van der Bie MD

BOLK'S COMPANIONS FOR THE STUDY OF MEDICINE

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About the Author

Guus van der Bie MD (1945) worked as a lecturer at the Department of Medical Anatomy and Embryology at Utrecht State University, Holland from1967 to1976. Next to his practice as a general practitioner since 1976, he continued to educate physicians and therapists, and medical students at Utrecht State University and the University of Witten/Herdecke, Germany. He is a member of the Medical Section of the School of Spiritual Science at the Goetheanum, Dornach, Switzerland.

About the Project

The project *Renewal of Medical Education* aims to produce Companions that demonstrate how the insights of current biomedical science can be broadened by using the Goethean phenomenological method. This method innovates current concepts and expands the understanding of biochemical, physiological, psychological, and morphological factors in living organisms and their development in time and space, and in health, illness, and therapy. The project is commissioned by the Kingfisher Foundation, which aspires the development, application, and publication of the Goethean phenomenological research method in the widest sense, to complement and innovate the accepted scientific view and research method.

BOLK'S COMPANIONS FOR THE STUDY OF MEDICINE complement current medical education, specifically disclosing human qualities in the fundamental biomedical sciences of today.

BOLK'S COMPANIONS FOR THE PRACTICE OF MEDICINE contribute to a scientific phenomenological basis for integrative medicine and integral psychiatry.

5. The Morphology of the Nervous System

5.1. Introduction

The nervous system is divided into a central nervous system, consisting of brain and spinal cord, (located within the cranium and the spinal column) and a peripheral nervous system that is formed by the spinal and peripheral nerves (located outside of the cranium and the spinal column).

5.2. The Central Nervous System

5.2.1. Early Development

The first developmental phase of the part of the central nervous system that develops intracranially is characterized by the creation of *brain vesicles*. The cranial portion of the original neural tube dilates vigorously in all directions, so that the - initially tubular - brain develops a wide lumen with a very thin wall (fig. 5.1.). In this spherically-shaped dilation

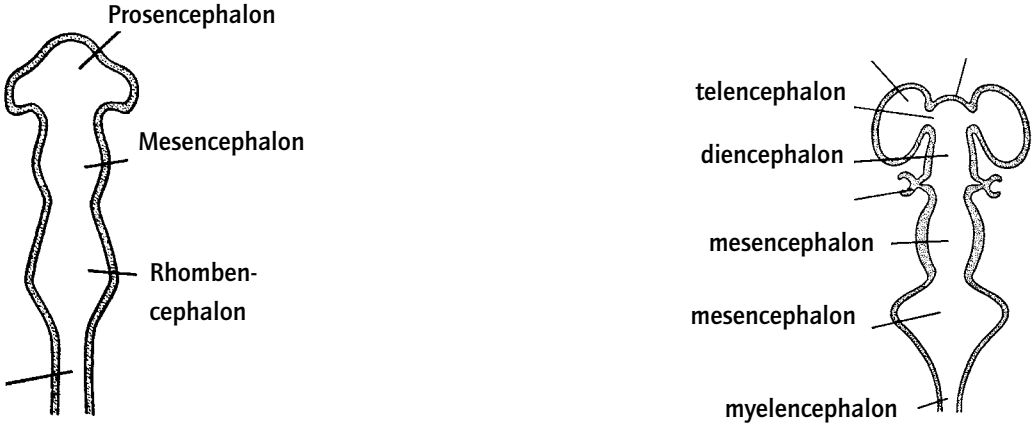
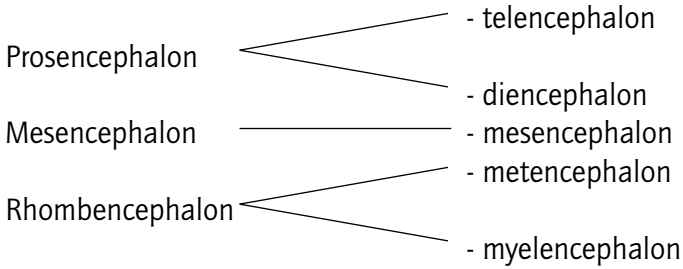


Fig. 5.1. Brain vesicles (Langman 1995)

of the neural tube, three areas can be distinguished from cranial to caudal: the prosencephalon, the mesencephalon and the rhombencephalon.

From these three brain vesicles, the definitive portions of the brain will develop as follows (fig. 5.1.):



5.2.2. The Telencephalon

On the telencephalic *vesicles* spherical bulges develop bilaterally into the two hemispheres of the cerebrum. Literally, the word 'hemisphere' means 'half a sphere.' This is an indication of the fact that the cerebrum, as a whole, can be seen as a complete *sphere*. Morphologically, we recognize the same characteristics as have been described for the skull in chapter 3.1.6.

The Development of Gray Matter

A second characteristic of the development of the cerebrum is the development of the *cerebral cortex* which mainly consists of neural cell bodies and is called the gray matter. Through extensive proliferation and folding, an extensive *surface* area of gray matter is formed. In the cerebral cortex are projection areas (such as the primary and secondary sensory cortex and the auditory and visual cortex) in which afferent fibers end and those where efferent filaments originate (such as the primary and secondary motor cortex). Projection areas are cortical areas that are via nerve fibers connected to specific areas of the body.

The entire body is represented in caricature form, but recognizable in overall shape, as it is

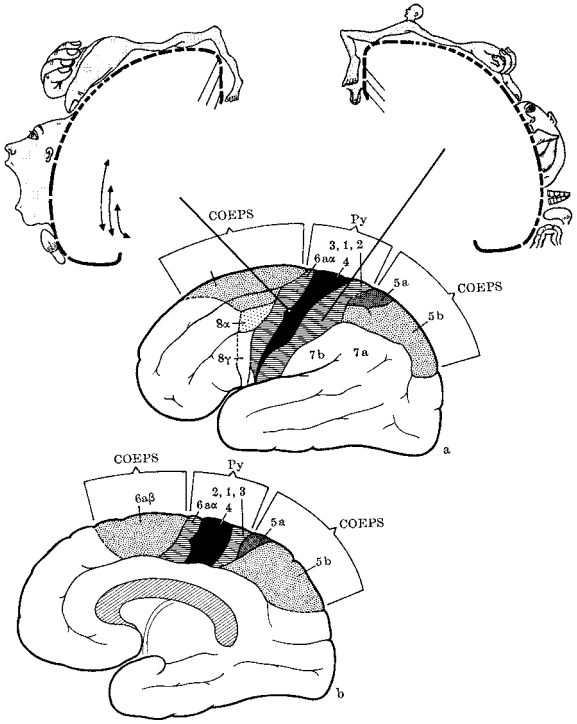


Fig. 5.2. Projection areas of the cerebral cortex (Rohen)

projected onto the motor and sensory cortex (fig. 5.2.). The relatively large surface areas that are allocated to the sensory and motor projection of the face, the mouth, the tongue, the senses, and the hand is particularly striking. The areas for the remaining regions of the body are notably small. This indicates a direct relationship between the density of innervation of the various regions of the body and the size of the corresponding projections areas (for example, mouth, tongue and hands).

Spheres and planes are morphologically characteristic of the cerebrum

The White Matter

The white matter of the cerebrum serves the *coordinating and integrative* functions of the nervous system, in particular the cerebrum itself. Association fibers connect various centers of the same side of the brain with each other (for example the longitudinal fasciculus and the cingulum). Commissures connect equivalent centers in the opposite brain halves with each other (for example the corpus callosum, the commissura anterior and the fornices).

The connection that is created between the cerebrum, the senses and lower portions of the central nervous system determines the *coordination and integration* of sensory and motor functions. They are, therefore, responsible for the ability of the human body to function as a whole, as a perceptive and reactive organism.

5.2.3. The Diencephalon

The diencephalon develops from the median portion of the prosencephalon which connects both primitive hemispheres with each other (fig. 5.1.).
The gray matter of the diencephalon develops as the main portion, consisting of thalamus, hypothalamus and neurohypophysis.
All three of these parts of the brain have *coordinating and integrating* functions: the thalamus with respect to the sensory/motor system, the hypothalamus with respect to autonomic functions, and the hypophysis integrates the activity of the metabolic organs regulated by endocrine glands, with the state of the autonomic nervous system in the organism. The pituitary gland is made up of two parts: the neurohypophysis which produces releasing factors, and the adenohypophysis which secretes hormones stimulating endocrine organs such as the thyroid (TSH), the gonads (gonadotropin hormones) and the adrenals (ACTH).
The hypothalamus regulates the integration of metabolism, via the pituitary gland.

5.2.4. The Cerebellum

In the cerebellum, the onset of a spherical configuration is also recognizable, albeit it on a smaller scale than in the cerebrum. We also find cortical *projection areas* in the cerebellum, comparable to those of the cerebrum, but now serving the *coordination* of movement. The cerebellum is connected to all pathways that are important to the motor system of the body.

5.2.5. Mesencephalon, Metencephalon, and Myelencephalon

Morphologically, these three areas of the brain are closely related to the structure of the spinal cord. They only determine, to a slight degree, the macroscopic form of the intracranial nervous system.
The larger number of the cranial nerves originate with their afferent and efferent nerve

fibers in the metencephalon and the myelencephalon. The first through fourth cranial nerves are either sensory afferent or motor efferent. Starting at the trigeminal nerve (V), the cranial nerves (with the exception of the abducent nerve VI) become increasingly mixed. Thus, in the cranial nerves, there is a development from caudal to cranial in which the cranial nerves become increasingly 'alienated' from the structure of the segmental spinal nerve: a mixed nerve containing both sensory and motor fibers.
The reticular formation is extended throughout the entire brainstem. This part of the nervous system occupies a central place in *regulating and coordinating* autonomic functions such as sleeping and waking, breathing, blood pressure, and temperature, and the regulation of the internal organs.

> ➔ *There is a morphological parallel between the head as a whole and the intracranial nervous system. Cranially, there is an accentuation of the spherical morphology in the neurocranium and the hemispheres of the cerebrum and the cerebellum; caudally, there is an accentuation of the morphology typical of the limbs and the peripheral nervous system.*

5.3. The Peripheral Nervous System

5.3.1. Radial Structure and Plexus Formation

Spinal nerves form plexuses. Plexus formation is a morphological characteristic of the peripheral nervous system. The cervicobrachial plexus and the lumbosacral plexus form the areas of origin of the peripheral nerves for arm and leg. From the plexus, the path of the nerves has a radial expansion. In a peripheral direction, the bifurcation and divergence of nerve fibers increases and reaches its maximum at the surface of the body. In the arms and legs, the rhythmical segmental structure of the spinal nerves looses its rigidity through plexus formation. The origin of metamerism can indeed be traced, but the nerves have been metamorphosed and recombined by plexus formation.
The autonomic peripheral nervous system has a comparable morphology. We also find plexus formation for the internal organs. In the autonomic nervous system (sympathetic as

well as parasympathetic), the plexus is the passageway for all nerve fibers. Only those fibers that are linked in a peripheral ganglion and which develop from preganglionic fibers into postganglionic fibers, become effective as autonomic efferent fibers.

➔ *The peripheral nervous system shows morphological plexus formation and the peripheral nerves have a radial structure. The relationship to the dynamics of the limbs is not only topographical, but also morphological.*

5.4. The Spinal Cord

5.4.1. Introduction

The configuration of the spinal cord is, morphologically, directly related to the structure of the spinal column in its location in the spinal canal and its segmental morphology.
The spinal cord with the spinal nerves and the spinal column with the ribs are both examples of metamerism: the anatomical form in which segmental elements are repeated and metamorphosed.

➔ *The blueprint and the relationships, such as are found between the vertebrae and the ribs, reoccur morphologically in the spinal cord and the segmental nerves.*

5.4.2. The Segmental Structure of the Spinal Nerves

In contrast to the cerebrum, the spinal cord is structured such that the gray matter is located centrally, for the most part and the white matter is located peripherally. White matter consists of long projection paths and in the gray matter the neurons are situated in which the connections occur. Because the afferent pathway (via the posterior spinal root) and the efferent pathway (via the anterior root) of each segment are situated close to each other, the anatomic condition for the *reflex arc* is created. From a neurophysiological

point of view, there is a continuous steering circuit that regulates the input and output of the afferent and efferent pathways in the reflex arc.

➔ *The rhythmic principle regulates systole and diastole in the heart and inhalation and exhalation in breathing. The same rhythmic principle governs the regulation of the reflex arc in which sensory (afferent) and motor (efferent) impulses regulate posture and movement.*

5.5. Nervous System and Consciousness

5.5.1. The Consciousness of the Head

The awareness of animals when they are awake and the self-consciousness of humans are directly related to the degree of development of the cerebrum. In this respect the relative weight of the human brain in comparison to the body weight, puts the human being in a unique position. The ability to be *aware of oneself* in observing one's surroundings (sensory) and the ability to be aware of oneself in activity (motor skills) are expressions of self-consciousness.

➔ *The intracranial nervous system is connected to conscious perception and intention, which occur during the waking state of consciousness. At this time in humans thinking occurs.*

5.5.2. The Consciousness of the Metabolic Organs, the Skeleton, and the Muscles

Neither animals nor humans consciously experience the processes of the metabolic organs, the muscles and the skeleton. Digestion, the mutual regulation of organ functions, and the use of muscle groups in movement, all of these functions occur completely unconsciously. It is normally impossible to influence this voluntarily. These bodily functions are primarily regulated by the autonomic nervous system.

Moving we are aware of the fact *that* we move, not *how* we move our muscles.

➔ *The autonomic nervous system is connected to the unconscious life of the organism, such as the functioning of the internal organs, muscles, and skeleton. This is the domain of metabolism. The form of consciousness corresponds to dreamless sleep or coma.*

5.5.3. The Consciousness of the Rhythmic Organs

In the thorax, we find a third form of consciousness: partially conscious, partially unconscious. The activity of the heart and breathing regulate themselves as internal organs. The activity of our heart can, however, be consciously perceived and, to some degree, we can even consciously influence our breathing. These rhythmic organs in particular, react to inner processes that have an effect at the organic level: moods and emotions.

➔ *The area of the rhythmic nervous system is related to a changing state of consciousness. This state of consciousness corresponds to the moments of light sleep in which emotions and events become, to a certain degree, conscious: dreaming. While awake, emotional life has its origin here.*

5.6. Goethean Aspects

Comparable to what has been said concerning the characteristic morphology of the skeleton, we can also find three different morphological qualities in the nervous system.

5.6.1. The Intracranial Nervous System: Sphere and Plane

Morphologically, we find a metamorphosis of the pursuit of a spherical structure in the

intracranial nervous system. The dilation of the neural tube into ventricles, the formation of the cerebral and cerebellar hemispheres, and the blueprint of the intracranial portion of the nervous system strive for the spherical form. The cortical projection areas develop with the characteristics of a plane. Just as with the skull, the relation between the cranial form (spherical) and the cranial bone (flat) can be seen in relation to the formation of the hemispheres and the projection areas.
Dynamically/functionally, perception via the senses, consciousness of the intent to move, and the integration of functions in waking consciousness are the most important.

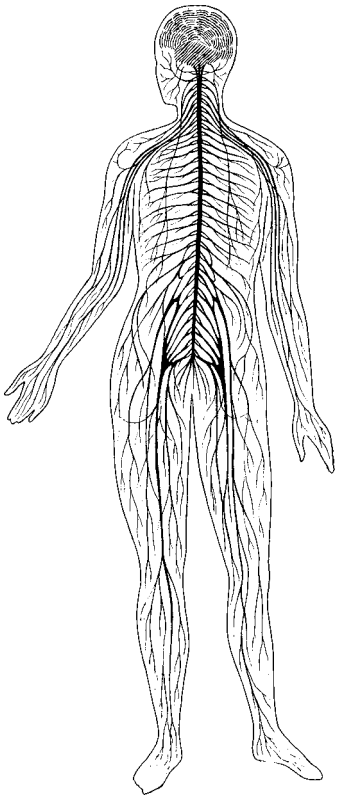


Fig. 5.3. Diagram of the nervous system (Vogel 1979)

5.6.2. The Peripheral Nervous System: Radial Structure

Morphologically, characteristic for the peripheral nervous system are its radial structure and its function in peripheral sensory and motor activity. The extremities, skin, and internal organs are innervated by nerves that originate from a plexus to reach their final destination.
It is striking that, just as has been said about the structure of the limbs, this section of the nervous system also subdivides in a peripheral direction.
Dynamically/functionally, the metabolic aspect of action occurs in this area where we are unconscious.

5.6.3. The Spinal Cord: the Rhythmic Nervous System

Morphologically, the entire spinal cord has a segmental structure. The segmental nerves are ordered according to the metameric principle. The metameric structures are here in morphological concordance with the spinal column and the thorax: they are *rhythmical.*

Morphologically, we find centripetal afferent fibers alongside centrifugal efferent fibers. The reflex arc is regulated by a rhythmic principle.
Dynamically/functionally, the reflex arc is basic for this portion of the nervous system.

➔ *Morphological and dynamical characteristics of the nervous system display a close relationship to the morphology and the dynamic of the skeletal parts they are connected to.*

Anatomy

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Can we give a scientific basis to our feeling that the human being has unique human features? Are the human mind and the human body 'nothing but' another variation of animal life? Can we find answers for these questions that satisfy both our head and our heart?

How these questions are answered depends on the scientific method we use. In this publication two methods are used: the current scientific method to learn about anatomical facts and the phenomenological method to understand the meaning of these facts.

Human morphology can then be understood as an expression of the unique and characteristic qualities of the human being. This results in new possibilities for understanding the relation between consciousness, psychology, behavior, and morphological aspects of the body.