

Vanya Goranova*, Violeta Tacheva**

Teaching neuroanatomical terminology in English as part of the language of medicine

ABSTRACT

Neuroanatomy is the study of the structural organization of the nervous system. Its terminology is closely related to the origin and development of medical terminology. Understanding linguistic phenomena such as etymology, synonyms, antonyms, paronyms, acronyms etc. helps the students in achieving a higher medical competence. The specific terms could be distributed into several categories related to: 1. geometric objects (pyramid, uncus, fornix); 2. colours (red nucleus, white matter, gray matter); 3. skull structures (lacrimal nerve – lacrimal bone, mandibular nerve – mandible); 4. author name (Schwann cells, Broca area, Parkinson disease). Some terms in the English terminology preserve their original Latin form (substantia nigra, corpus callosum) but others are modified (red nucleus, Latin - nucleus ruber). This model of investigation may be applied to other medical disciplines.

Key words: Neuroanatomical Terminology, Etymology, Synonyms, Antonyms, Paronyms, Eponyms, Mythonyms, Toponyms, Acronyms, Backronyms

Introduction

Human anatomy is the science of the human body's structure. It is a basic biomedical morphological science which has arisen and developed closely to medicine - a science and art for diagnosis, treatment and prophylaxis of diseases. There are different anatomical disciplines (gross anatomy, cytology, histology, embryology), various

* Correspondence address: Vanya Goranova, Department of Anatomy, Histology and Embryology; 2 Medical University, 55 Marin Drinov Str., 9002 Varna, Bulgaria, e-mail: vanya.goranova@mu-varna.bg

** Correspondence address: Violeta Tacheva, Department of Foreign Languages, Communication and Sport, Medical University, 55 Marin Drinov Str., 9002 Varna, Bulgaria, e-mail: tacheva@mu-varna.bg

approaches (systemic, topographic, plastic, comparative, applied, clinical) or levels (macroscopic, microscopic, ultramicroscopic, molecular) to study the human body.

Neuroanatomy studies the structural organization of the nervous system. It is an organ system containing a network of specialized cells called neurons that coordinate the actions of body and transmit signals between its different parts. Traditionally, neuroanatomy has been seen as a branch of neurobiology. This term refers specifically to the biology of the nervous system. It is used interchangeably with neuroscience that is an interdisciplinary science of the nervous system. It has broadened including molecular, cellular, structural, functional, developmental, evolutionary and medical aspects in studying the nervous system. Neuroscience currently collaborates with other fields such as chemistry, physics, engineering, computer sciences, mathematics and related disciplines - linguistics, philosophy, and psychology in studying the human nervous system, particularly the human brain. It is a unique structure that shows the most complex three-dimensional architecture in the human body. Neuroscientists are only beginning to understand how the different parts of this intricate configuration work together to produce behavior.

One of the greatest challenges faced by students of anatomy is the vocabulary. Knowledge about linguistic phenomena such as etymology, synonyms, antonyms, paronyms, acronyms, eponyms, mythonyms, toponyms, backronyms etc. will be helpful to the students in acquiring better neuroanatomical skills.

Aim of the Study

The aim of our study was to analyze and categorize the majority of neuroanatomical terms in the context of anatomical teaching process in English.

Linguistic Phenomena of Neuroanatomical Terminology

1. General Characteristics

The origin of neuroanatomical terms is related to anatomical and medical terminology as a whole. Medical terminology is a language for accurately describing the human body and associated components, conditions, and processes in a science-based manner.

The modern Terminologia Anatomica (TA) was codified in 1998 by an international body of anatomists, the Federative Committee on Anatomical Terminology. It is based on the three previously used Nomina Anatomicae:

- Basel Nomina Anatomica (BNA), 1885

- Jena Nomina Anatomica (JNA), 1935
- Paris Nomina Anatomica (PNA), 1955

The succession between single Nominae with admitted corrections and additions at various international anatomical congresses: New York, 1960; Wiesbaden, 1965; Tokyo, 1975; Mexico-city, 1980 and Antwerpen, 1985 are the main foundations of the current TA.

2. Etymology

Medical terminology mostly uses ancient Greek and Latin words or their derivatives created using prefixes and suffixes⁽¹⁾. About 90% of today's medical terms are formed from just 1200 Greek and Latin roots. This systematic approach to word building and term comprehension is based on the concept of: (1) word roots, (2) prefixes, and (3) suffixes. In medicine, their meanings, and their etymology, are informed by the language of origin. The process of learning a new language, such as medical terminology, is a challenging, yet attainable goal as the basic rules. Decoding the medical terms is an important process. Once experience is gained in the process of forming and decoding medical terminology, the learning process becomes easier. Medical roots generally go together according to language: Greek prefixes go with Greek suffixes and Latin prefixes with Latin suffixes. One approach involves breaking down the word by evaluating the meaning of the suffix first, then prefix, and finally the word root. When in doubt, the result should be verified by a medical terminology dictionary.

Latin grammatical categories such as noun, adjective, gender, number, declension (case), conjugation and word composition represent important linguistic phenomena. They create very often difficulties when teaching medical students neuroanatomical terminology in English. Common Latin terms in neuroanatomy belong to three different genders: masculine (M), feminine (F) or neuter (N) manifested in nouns and adjectives with various endings in singular and plural in the most used nominative case (for examples see table 1). There are five declensions in the Latin medical terminology (first, second, third, fourth, and fifth).

Sometimes confusion arises because of double origin of specific terms for many structures. Latin language is used for purely anatomical terms and their derivatives, e. g. cerebrospinal fluid (from Latin - cerebrum, i.e., brain), whereas Greek language is preferred for clinically related terms, e. g. encephalitis (brain inflammation). The anatomical term cerebrum, which is just Latin for "brain", is the largest portion of the brain. Actually, cerebrum means not the whole brain but only one part of it that is synonymous with telencephalon. Encephalon is the clinical term for brain. Its origin is from new Latin that comes from ancient Greek ἐγκέφαλος (enkephalos,

"within the head") from ἐν (en, "in") + κεφαλή (kephalē, "head"). Very often brain related anatomical structures are defined as cranial. Cranial is an adjective related to the cranium, the Latin term for skull, e.g. cranial cavity. Cranial nerves are nerves that emerge directly from the brain, in contrast to spinal nerves, which emerge from segments of the spinal cord.

Table 1.

Examples	Gender	Singular ending	Plural ending	Declension
nervus, nervi	M	-us	-i	2 nd
cortex, cortices	M	-ex	-ices	3 rd
fossa, fossae	F	-a	-ae	1 st
facies, facies	F	-es	-es	5 th
septum, septa	N	-um	-a	2 nd
ganglion, ganglia	N	-on	-a	3 rd

3. Synonyms and Antonyms

Synonym is a word having the same or nearly the same meaning as another word or other words in a language. Antonym - from the Greek anti ("opposite") and onoma ("name") is a word having a meaning opposite to that of another word. In neuroanatomy, antonyms are gradable opposites (brevis and longus, pre- and post-, minor and major, anterior and posterior etc.), e.g. gyrus brevis (short) and gyrus longus (long) in insula, precentral sulcus and postcentral sulcus, forceps minor and forceps major.

Table 2.

	Synonyms	Meaning	Synonyms	Meaning
Antonyms	Anterior	Toward the ventral side	Posterior	Toward the dorsal side
	Ventral	Toward the front or belly	Dorsal	Toward the back or spine
	Superior	Above	Inferior	Below

When applied to the brain, anterior is synonymous with ventral, superior, cranial or rostral. Rostral (a beak-like structure) refers to anatomical location or direction meaning towards the rostrum. Posterior is synonymous with dorsal, inferior or caudal (from Latin caudum, i.e., tail). Anterior and its synonyms are all antonyms with posterior and its synonyms (see table 2).

Some additional explanations are necessary for the students to better understand the meaning of these terms and the differences in their application to other regions of the human body. As with other vertebrates, two of the most obvious extremes are the "top" and the "bottom" of the organism. In standard anatomical position, these correspond to the head and feet, respectively in humans. The head end is referred to as the superior end (Latin superior: "above"), while the feet are referred to as the inferior end (Latin inferior: "below")⁽²⁾. As with other vertebrate terminology, there are synonymous terms for anterior and posterior. The most obvious end-points are the "nose" and "tail". In terms of anatomy, the nose is referred to as the anterior end (Latin ante; before). In organisms like vertebrates, that have distinct heads, the anterior end is sometimes referred to as the rostral end (Latin rostrum; beak), the cranial end (Greek kranion; skull), or the cephalic end (Greek kephalē; head)⁽³⁾. The terms cranial and cephalic are often encountered. "Cranial", as a reference to the skull, is fairly commonly used, whereas "cephalic" is uncommonly used. The polar opposite to the anterior end is the posterior end (Latin post; after). Another term for posterior is caudal (Latin cauda; tail, though in humans this refers to the feet, i.e., inferior rather than posterior) - a term that strictly applies only to vertebrates, and therefore less preferred, except in veterinary medicine where these terms are standard. The term "rostral" is rarely used in human anatomy, referring more to the front of the face than the superior aspect of the organism. Similarly, the term "caudal" is occasionally used in human anatomy.

4. Paronyms

Paronyms are words with similar pronunciations but different spellings and meanings. There are many paronymous terms in the field of neuroanatomy like: forceps - fornix - falx; fasciculus - funiculus; paleostriatum - neostriatum; allocortex - isocortex - archicortex - paleocortex - neocortex; archicerebellum - paleocerebellum - neocerebellum; mesencephalon - metencephalon; rhinencephalon - rhombencephalon; tapetum - tectum - tegmentum - tentorium; septum - splenium - striatum; pallium - pallidum; pulvinar - putamen etc.). These type of terms combined with other fractional, synonymous or antonymous neuroanatomical terms create a real challenge in their understanding and learning, e. g. septum pellucidum - splenium corporis callosi - striatum - paleostriatum - neostriatum - stria longitudinalis medialis - stria longitudinalis lateralis.

5. Eponyms

Eponyms in neuroanatomy are terms coined from the names of people contributing to description or study of the respective structure. Such structures are Broca's gyrus - cortical motor speech area (from Pierre Paul Broca, 1824-1880, a French anatomo-

mist, physician, surgeon, anthropologist); Wernicke's area (from Carl Wernicke, 1848-1905, a German anatomist, physician, neuropathologist, psychiatrist); Brodmann's areas - specific functional cortical areas (from Korbinian Brodmann, 1868-1918, a German anatomist and neurologist who has described 52 distinct regions of the cerebral cortex according to their cytoarchitectonics (histological characteristics); Alzheimer's disease; Parkinson's disease; Huntington's disease etc.

Sometimes explaining the students the meaning of an eponym together with its etymology and giving some interesting additional information play a crucial role in the effective neuroanatomy teaching. A nice example in this meaning are the "Motor and Sensory Homunculus"⁽⁴⁾ introduced by Penfield and Rasmussen. Wilder Graves Penfield (1891-1976), a Canadian neurosurgeon, and Theodore Brown Rasmussen (1910-2002), an American neurosurgeon, are two neuroscientists who made fundamental contributions to neurocytology and neurophysiology, including functions of the cerebral cortex, speech mechanisms, and pathological changes underlying epilepsy. A cortical homunculus is a pictorial representation of the anatomical divisions of the primary somatosensory cortex and the primary motor cortex, i.e., the portion of the human brain directly responsible for the exchange of sensory and motor information of the body. There are two types of homunculus: sensory and motor. Each one shows a representation of how much of its respective cortex innervates certain body parts. The 3-D models of both "Motor and Sensory Homunculus" are exposed to visitors in the Natural History Museum in London.

6. Toponyms and Mythonyms

In linguistics, toponyms or terms derived from place names have been used to reveal historical land-use patterns whereas mythonyms are terms derived from mythological names. Toponyms are names to denote or identify human habitation sites (cities, towns, villages etc.), natural geographic features (mountains, rivers, lakes, bays, seas etc.), and political boundaries (states, municipalities etc.). They identify and reflect culture, heritage and landscape, and therefore offer much to cartographers, geographers, historians, genealogists, linguists, language planners, and tourists.

There are very few toponyms and mythonyms in neuroanatomy. One of these is arbor vitae (Latin for "Tree of Life") that is the cerebellar white matter, so called for its branched, tree-like appearance. The arborvitae is an evergreen tree or shrub from the cypress family. They are found primarily throughout eastern Canada and the northeastern United States. Arbor Vitae is also a small town in Vilas County, Wisconsin, United States. The concept of a tree of life has been used in science, religion, philosophy, mythology, and other areas. A tree of life is a common motif in various world theologies, mythologies, and philosophies; a mystical concept alluding to the

interconnectedness of all life on our planet; and a metaphor for common descent in the evolutionary sense⁽⁵⁾.

Another interesting mythonym is the term hippocampus that is synonymous to Ammon's Horn (Cornu Ammonii). The word hippocampus comes from late Latin: hippocampus, derived from the Greek words for a horse sea monster. In classical myth and legend, the hippocampus is a mythological sea creature with the forelegs of a horse and the tail of a fish, represented as drawing the vehicle of Neptune the sea God. The other term Ammon's horn is a metaphor that refers to the ram shaped horns on the head representing the Egyptian God Amun. The Greek form of the name was Ammon. Neurologists recognise the hippocampus as each of two elongated eminences (hippocampus major and minor) on the floor of each lateral ventricle of the brain; so called from their supposed resemblance to the fish. With its base in ancient classical history, neuroanatomical terminology provides several metaphors that relate the gods and the brain⁽⁶⁾.

7. Acronyms and abbreviations

Acronyms and abbreviations - words composed of the first letter, or first few letters, of a series of words. Some examples from the field of neuroanatomy could be mentioned such as FP - frontal pole, TP - temporal pole, PARC - paracentral lobule, PORB - pars orbitalis, CUN - cuneus, PCUN - precuneus, etc. The abbreviation of Ammon's Horn is CA. It possesses additional numeration CA1, CA2, CA3, CA4 indicating the four main histological divisions of the hippocampus. Neuroanatomical acronyms and abbreviations are not applied as much as in other medical fields.

8. Backronyms and Mnemonics

A backronym or bacronym is a phrase constructed purposely by taking an existing word already in common usage, and creating a new phrase using the letters in the word as the initial letters of the words in the phrase. Backronyms can be constructed for educational purposes, for example to form mnemonics. A mnemonic or mnemonic device (memory-aiding), is any learning technique that aids information retention. Mnemonics aim to translate information into a form that the human brain can retain better and even the process of applying this conversion might already aid the transfer of information to long-term memory. Commonly encountered mnemonics are often for lists and in auditory form, such as short poems, acronyms, or memorable phrases. Mnemonic phrases and ditties, ranging from the sublimely silly to the unprintably ribald, are used to help generations of medical students remember the cranial nerves. Such a mnemonic phrase with the

first letter(s) of each word matching the first letter(s) of each of the twelve cranial nerves is the following one⁽⁷⁾:

Old	Olfactory (I)
Opie	Optic (II)
Occasionally	Oculomotor (III)
Tries	Trochlear (IV)
Trigonometry	Trigeminal (V)
And	Abducens (VI)
Feels	Facial (VII)
Very	Vestibulocochlear (VIII)
Gloomy	Glossopharyngeal (IX)
Vague	Vagus (X)
And	Accessory (XI)
Hypoactive	Hypoglossal (XII)

Types of Neuroanatomical Terms

For an easier explanation and a better understanding, the specific terms could be distributed into several categories related to:

- Geometric objects or bodies: pons, cingulum, pyramid, crus, olive, insula, claustrum, pulvinar, cornu, uncus, fornix, vermis, dentate gyrus, calcar avis, corona radiata, limbic system, falx cerebri, falx cerebelli, pes hippocampi etc.;
- Colours: substantia nigra, red nucleus, white matter, gray matter, tuber cinereum, locus ceruleus etc.;
- Skull structures: lacrimal nerve - from lacrimal bone, mandibular nerve - from mandible, frontal nerve - from frontal bone, maxillary nerve - from maxilla etc.;
- Author names or eponyms: Golgi apparatus, Nissle bodies, Schwann cells, Betz cells, Broca's area, aqueduct of Sylvius, Reissner's membrane, Parkinson disease etc.

To avoid confusion in the English medical terminology, some terms have preserved their original Latin forms, e.g. substantia nigra, corpus callosum, corpus striatum, corona radiata etc., but others are modified in English, e.g. red nucleus (Latin - nucleus rubber), ventricle (Latin - ventriculus), tract (Latin - tractus) etc.

Aspects, Approaches and Methodology

There are some important aspects when teaching neuroanatomical terminology, i.e.:

- Different levels of organization of the human body: molecular, ultramicroscopic, microscopic (cells, tissues), macroscopic (organs, systems, apparatuses);
- Various classical methods and modern imaging techniques available for studying the nervous system: dissection, microscopy, radiography (x-rays), angiography, computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET) etc.;
- Different anatomical disciplines: cytology (cell biology), histology, embryology, systemic anatomy, comparative anatomy, topographic (regional) anatomy, clinical (practical) anatomy etc.;
- Different biological and clinical disciplines: physiology, biochemistry, pathology, neurology, neurosurgery, psychiatry etc.

A complex approach combining aspects from various levels, methods and disciplines, including structural and functional aspects, has to be applied to successfully teach neuroanatomy. The main focus in the methodology of teaching should be directed in binding the acquisition of a solid theoretical knowledge with clinical skills in the field of human nervous system and especially its center - the brain. Very often appropriate comparative, historic, practical or other additional data attract student attention and assist terminology retention. Some examples giving ideas on the above mentioned aspects and approaches are presented here below.

The human brain has the same general structure as the brains of other mammals, but is much more larger than expected on the basis of body size among other primates. Most of the expansion comes from the cerebral cortex, especially the frontal lobes, which are associated with executive functions such as self-control, planning, reasoning, and abstract thought.

Neurodegeneration is the umbrella term for the progressive loss of structure or function of nerve cells (neurons), including death of neurons. Many neurodegenerative diseases such as Parkinson's, Alzheimer's, and Huntington's occur as a result of neurodegenerative processes. Neurodegeneration can be found in many different levels of neuronal circuitry ranging from molecular to systemic. As research progresses, many similarities appear which relate these diseases to one another on a sub-cellular level. Discovering these similarities offers hope for therapeutic advances that could ameliorate many diseases simultaneously⁽⁸⁾. Most of the names of neurodegenerative diseases are eponyms - Alzheimer's disease, Parkinson's disease, Huntington's disease, Multiple sclerosis etc. that are used in abbreviations such as: AD, PD, HD, MS respectively.

Alzheimer's disease (AD) is the most common form of dementia. It was first described by the German psychiatrist and neuropathologist Alois Alzheimer (1864-1915) in 1906 and was named after him. There is no cure for the disease, which worsens as it progresses, and eventually leads to death.

Parkinson's Disease (PD) is named after the English doctor James Parkinson (1755-1824), who published the first detailed description in *An Essay on the Shaking Palsy* in 1817. He was the first to describe "paralysis agitans", a condition that would later be renamed Parkinson's disease. The motor symptoms of Parkinson's disease result from the death of dopamine-generating neurons in the substantia nigra. Two world-famous personalities suffer from Parkinson's disease. These are Michael J. Fox, (1961-), a Canadian/American film and television actor, who has Parkinson's disease since 1990 and Muhammad Ali (1942-), an American boxer, who has Parkinson's disease since 1984.

Conclusions

There are various difficulties and problems when teaching the language of medicine and especially neuroanatomical terminology in English. Contemporary challenges of the teaching process are mainly the new interdisciplinary, intercultural and communication aspects. Our linguistic model of investigation and complex teaching approach may be applied by other medical disciplines for better results.

The mystique of the brain continues to intrigue modern biologists, physicians and psychologists even as it did the philosophers of antiquity. The relationship of the mind or personality to the cellular function of the brain is a question that will provide fertile ground for scientific study and philosophical debate long into the future.

REFERENCES:

1. http://en.wikipedia.org/wiki/Medical_terminology (27 July 2012).
2. Tortora G. J. and Derrickson B., Principles of Anatomy and Physiology, 11th ed. Wiley, Hoboken, NJ, 2006, p. 14.
3. http://en.wikipedia.org/wiki/Anatomical_terms_of_location (1 August 2012).
4. http://en.wikipedia.org/wiki/Cortical_homunculus (2 August 2012).
5. http://en.wikipedia.org/wiki/Arbor_vitae (2 August 2012).
6. Pearce J. M. S., Ammon's horn and the hippocampus., J. Neurol. Neurosurg. Psychiatry, 2001, 71(3), p. 351.
7. Saladin K., Anatomy and Physiology: The Unity or Form and Function. 4th ed. McGraw-Hill, 2007, p. 541-543.
8. <http://en.wikipedia.org/wiki/Neurodegeneration> (5 August 2012).