EUROMEDITERRANEAN BIOMEDICAL JOURNAL
2023,18 (5) 23-29
(*FORMERLY: CAPSULA EBURNEA*)

**Review**

# SOMATOTOPY OF THE FACIAL NUCLEUS: A COMPARATIVE ANALYSIS WITH CLINICAL REMARKS

*Elvira Vittoria Farina [1], Alessio Lipari [2], Luana Lipari [3]*

*1. Retired Professor of Human Anatomy, University of Palermo, Palermo Italy.*
*2. Department of Neurology, Hospital "Sant'Antonio Abate" Trapani, Italy.*
*3. Department of Medicine and Surgery of Acceptance and Emergency Emergency Area - Emergency Room (MCAU) of the Villa Sofia Hospital in Palermo, Italy.*

**ARTICLE INFO**

*Article history:*
*Received 19 Jan 2023*
*Accepted 24 Feb 2023*
*Published 18 Mar2023*

Keywords:
Facial nucleus, Facial Nerve, anatomy, motor nerve, sensitivity nerve.

**ABSTRACT**

Stemming from our previous studies regarding somatotopy of the spinal cord, oculomotor complex and trigeminal complex, we developed this study of the somatotopy of facial nuclei to compare the musculotopic organization of the facial nucleus in different mammals. The results suggest that a basic pattern of muscle representation exists in the cranial nerve VII that is common to all mammals: the subnuclei innervating the nasolabial musculature are located in the lateral portions of the nucleus, while the auricular musculature is innervated by motor neurons located in the medial parts of the nucleus. In humans, it was identified that the facial motor nucleus has a dorsal and a ventral region: the neurons in the dorsal region innervate the muscles of the upper face, and the neurons in the ventral region innervate the muscles of the lower face. Interestingly, the neurons in the dorsal portion of the facial motor nucleus receive input from both sides of the cortex, while those in the ventral aspect mainly receive controlateral input. The result is that both cerebral hemispheres control the muscles of the upper face, and each controls the controlateral lower face. The study and knownledge of the somatotopy of the facial nucleus can be useful for greater precision on the damaged part of the nucleus and the nerves originating from it, and therefore a more precise surgery and monitoring of maxillo-facial tumors.



## 1. Introduction

"Cranial Nerve VII" was first described by Galen (129-200 AD) who identified seven "cranial nerves: I optic; II oculomotor; III and IV trigeminal; V facial and auditory; VI glossopharyngeal, vagus and accessory; VII hypoglossus", so the "facial nerve" was considered as "part of the facial-vestibulocochelar complex". Next, the "intermediate nerve" was identified by Eustachius in 1563 and later by Wrisberg in 1777 as "portio media inter comunicantem faciei et nervum auditorium." It was not until Bell, in the 1800s, when both the motor and sensory components of the facial nerve were distinguished. In 1881, Sapolini definited and named the 13th nerve the "intermediate nerve" for its position between the facial nerve and the upper portion of nerve VIII, which was recently considered an independent nerve structure.

Facial nerve/VII cranial nerve (1) is a complex comprising the "facial nerve" and the "intermediate nerve," known as the "intermediate-facial nerve," and contains both sensory and motor fibers. The sensory fibers transmit touch, pain, and pressure information from the tongue, soft palate, and pharynx, and they terminate in the solitary nucleus. The motor fibers produce facial expression, eyelid closure, provide the corneal and stapedial reflex. The "intermedius nerve" also includes motor fibers innervating the salivary, lacrimal and nasal glands.

Stemming from our previous studies regarding somatotopy of the spinal cord, oculomotor complex and trigeminal complex, we developed this study of the somatotopy of facial nuclei. Additionally, we performed an analysis of the literature data on somatotopy of the motor facial nucleus to see if there is any correspondence between other mammals and humans.

* Corresponding author*:* Elvira Vittoria Farina, *farina.elviravitt@tiscali.it*
DOI: 10.3269/1970-5492.2023.18.5

## 2. Facial nerve anatomy

The “facial nerve” (2) is commonly divided into “4 segments: the nucleus and tracts, the cistemal segment that tranverse the internal auditory canal, the intratemporal segment (through the bony facial nerve canal), and the peripheral segment."

The “facial nerve” anatomically arises from the “facial nucleus” and emerges from the pontomedullary junction, at supra-olivar pit, by two roots: 1) the motor root conveying fibers to muscles derived from the mesoderm of the second branchial arch, 2) the nervus intermedius connecting the visceral sensory fibers from the tongue and palate, and preganglionic parasympathetic fibers to the pterygopalatine and submandibular ganglia. The two roots unite in the “internal acoustic meatus.” At the lateral end of the meatus, the facial nerve passes into the “facial canal.” The nerve then turns sharply posteriorly at the geniculum, where the “geniculate sensory ganglion” is located, and the greater petrosal nerve of the pterygopalatine ganglion emerges from this region. The “facial canal” continues posteriorly on the medial wall of the tympanic cavity, passing above the fenestra vestibuli and arching downward and laterally emerging at the “stylomastoid foramen” just after the “chorda tympani nerve” termination.

The “facial nerve” (3), after emerging through the stylomastoid foramen, curves downward and ventrolateral and enters the retromandibular fossa lateral to the external carotid artery and the retromandibular vein. Before the “facial nerve” enters the parotid gland, it divides into the “posterior auricular nerve” and the “nerves to stylohyoid and posterior digastric muscles.”

Inside the parotid gland, the facial nerve runs between the deep and superficial lobe until it emerges beyond the anterior border of the gland to continue up to the facial muscles with two main divisions after bifurcation, the temporofacial and the cervicofacial branches, which divide into five terminal branches: temporal, zygomatic, buccal, marginal or mandibular, and cervical. The temporal and zygomatic branches always originate from the temporofacial division; however, the mandibular and cervical branches always arise from the cervicofacial division. The buccal branch is the only with one variable origin.

The “facial nerve” is divided into five groups of peripheral distal branches:

1) the “temporal branch,” which emerges at the superior limit of the parotid gland and is subdivided into 1-5 branches innervating the muscles of the upper portion of face, frontalis, orbicularis oculi and corrugator muscles;

2) the “zygomatic branch,” which innervates muscles of the intermediate portion of the face, the zygomatic muscle, and the orbicular oculi muscle;

3) the “buccal branch” which runs alongside the parotid duct over the masseter and buccinator muscles innervating the cheek muscles, the zygomatic muscles, orbicularis oris, and levator labii superioris.

4) the “mandibular branch,” which crosses the facial artery at the inferior limit of the parotid gland, innervates the muscle of the lower portion of face, the “depressor labii inferioris.”

5) the “cervical branch,” which innervates the submental and platysma muscles and has 1-3 branches to the neck.

## 3. Facial nerve sensory component

The sensory component (4, 5) of the facial nerve is comprised of “fibers” which originate from the “protoneurons” located in the “geniculate ganglion.” These are distinguised by:

1) “Fibers or peripheral processes” of the protoneurons conveying touch, thermic, and nociceptive information from the auricule and external auditory canal, and “fibers or central processes” of the protoneurons in contact with the intermedius nervus, united with fibers of the trigeminal nerve, and terminating in the “spinal trigeminal nucleus”;

2) “Fibers or peripheral processes” of the protoneurons conveying information along the major petrous nerve innervating the nasal mucosa, paranasal sinuses, and a part of the soft palate, and “fibers or central processes” which enter in contact with the intermedius nerve and terminate in the “nucleus of the solitary tract”;

3) “Fibers or peripheral processes” of protoneurons running in the “lingual nerve” and “chorda tympani,” synapse with receptors of taste buds of 2/3 of the anterior portion of the tongue, “fibers or central processes” enter in contact with the intermedius nerve just laterally of the motor root of the facial nerve at the bulbo-pontine junction, and rostrally to the inferior olive, entering into the “solitary tract” and terminating in the “rostral part of the solitary nucleus called gustative nucleus.”

## 4. Motor facial nucleus

The facial motor nucleus (6) is situated in the caudal part of the reticular formation in the pons, posteriorly to the “dorsal nucleus of the trapezoid body” and anteriorly to the “spinal tract of the trigeminal tract”.

In 1927, Papez (7) identified the “facial nucleus” in feline cytoarchitectonically and subdividing it into “ventromedial, ventrolateral, lateral, dorsal, intermediate and medial divisions.” Successively, in 1966, Courville and coll. (8) identified four subgroups in the “facial nucleus” that give rise to branches or nerves innervating single muscles as described in the following table (Table 1).

| *Subgroups* | *Branches or Nerve* | *Muscle* |
|---|---|---|
| Dorsomedial | Auricular posterior | Occipital, auricular. |
| Ventromedial | Cervical | Platysma. |
| Intermediate | Temporal, zygomatic | Frontalis, orbicularis oculi, corrugator supercilii, zygomatic. |
| Lateral | Buccal | Buccinator, buccolabial superior and inferior. |

**Table 1. Subgroups (four) of facial nucleus in feline (8).**

In cats, the dorsomedial group is the most prominent, possibly due to the importance of the auricular musculature.

The greatest amount of stapedius motoneurons (9) were located around the motor nucleus of the facial nerve. Staphedius motoneurons were also found near the descending limb of the facial-nerve root, in the peri-olivary neuropil, and in the reticular formation with the ascending fibers of the facial-nerve root.

The stapedius muscle manifests the stapedius reflex pathway, which is the involuntary contraction caused by excessive stimulation of the inner ear and involves 3-4 neurons: “primary auditory afferent,” and “cells of the ventral cochlear nucleus” with their axons in the “trapezoid body” in partial contact with the ipsilateral stapedial motoneurons located for the most part medially in the facial motor nucleus.

The stapedial reflex has a protective function towards the the inner ear, as well as an extension of the auditory field and improvement of the discriminative capacity in noise, increasing the ability to understand speech (medium-acute components) in noisy environments.

In cats, Kume and coll. (10), by utilizing retrograde axonal transport of horseradish peroxidase, found that within the facial nucleus the representation of peripheral branches of the facial nerve was as decribed in the following table (Table 2).

| *Division* | *Branch* |
|---|---|
| Ventromedial | Cervical |
| Medial | Posterior auricular |
| Intermediate | Temporal |
| Dorsal | Zygomatico-orbital |
| Lateral | Superior labial |
| Ventrolateral | Inferior labial |

**Table 2. Subgroups (six) of facial nucleus in cat (10).**

In cats (11), the facial nucleus receives the projections from the regions of the contralateral red nucleus, which receives basal gangliar inputs and transmits them to the facial nucleus and cervical spinal cord, therefore, the red nucleus controls movements of the head and face.

In rats (12), the facial nucleus can be divided into 5 morphological subdivisions as shown on the following table (Table 3).

| *Subnuclei or subdivisions* | *Branch* |
|---|---|
| Medial | Auricular posterior |
| Ventromedial | Cervical |
| Lateral | Inferior/superior buccolabiales |
| Dorsal | Zygomatic |
| Intermediate | Temporal and digastric |

**Table 3. Subgroups (five) of facial nucleus in Rat (12).**

The results are consistent with an organization of the motor nucleus reflecting a corresponding topographic organization of the facial musculature. In rats (13), the facial nucleus, by retrograde transport of HRP, can be divided into "longitudinal columns": those supplying the nasolabial muscles, which are in the lateral and ventral intermediate segments; posterior auricular muscles in a medial column; platysma in an intermediate column; the lower lip in an intermediate ventral column segment; ocular muscle in an intermediate dorsal column segment. The posterior belly of the digastric muscle is innervated by motoneurons extending from the dorsal aspect of the facial nucleus to the caudal pole of the trigeminal motor nucleus (Table 4).

| Column | Muscles |
|---|---|
| Intermediate segment ventral | Nasolabial |
| Intermediate segment lateral | Nasolabial |
| Medial | Auricular posterior |
| Intermediate | Platysma |
| Intermediate segment ventral | Lower lip |
| Intermediate segment dorsal | Ocular muscles |

**Table 4. Columns (six) of facial nucleus in rat (13).**

In mice (14), the data concerning the musculotopic organization of the facial nucleus are in general agreement with findings in other animals.

The lateral portions of the nucleus supply facial musculature in the nasolabial regions, and the medial portions supply the auricular musculature. The nasolabial musculature is represented by a relatively large portion of the facial nucleus, the lateral and dorsolateral subnuclei (Figures 1a, 1b).

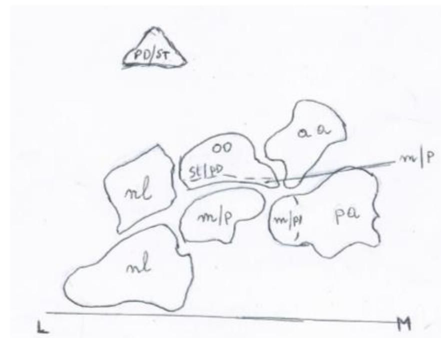


**Figure 1a. Nuclear map with the muscles in subnuclei of the adult mouse facial nucleus: nl, nasolabial; oo, orbicularis oculi; aa, anterior auricular musculature; pa, posterior auricular musculature; pd, posterior belly of the digastric muscle, st, stapedius muscle; mentalis musculature; p, platysma.**

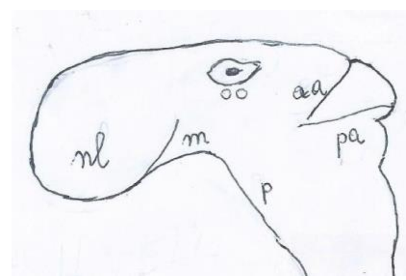


**Figure 1b. Map of regiones of the distorted facies with the areas corresponding to the size of the portions of the subnuclei, showed in figure 2, which supply them. Figure modified from Ashwell (14).**

In guinea pigs (15), the facial nucleus was divided cytoarchitectonically into the dorsolateral, lateral, intermediate, medio-intermediate, medial, and ventromedial divisions. The ventromedial division was further divided into the major, dorsal and lateral parts. Six main branches of the facial nerve were identified: the zygomatico-orbital, cervical, posterior auricular, anterior auricular, superior labial, and inferior labial branches. Within the facial nucleus, a correspondence was found between the subnuclei or divisions, and the main branches of the facial nerve as shown in the following table (Table 5).

| Subnucleus | Branch |
|---|---|
| Dorsolateral | Zygomatic-orbital |
| Ventromedial (dorsal part) | Cervical |
| Ventromedial (major part) | Posterior auricular |
| Ventromedial (lateral part) | Anterior auricular |
| Medial | Superior labial |
| Lateral | Superior/inferior labial |
| Intermediate | Superior/inferior labial |
| Medio-intermediate | Superior/inferior labial |

**Table 5. Subnuclei (six) of facial nucleus in Guinea pig (15).**

In guinea pigs, Reuss and coll. (16) observed that the neurons located medially and ventrally to the nucleus of the facial nerve ipsilateral innervate the stapedius muscle.

In rabbits, Satoda and coll. (17) observed that the facial nucleus is cytoarchitectonically divided into 5 divisions: ventromedial, medial, dorsal, lateral, and intermediate. The correspondence between the division or subnuclei and supplied branches of the facial nerve is shown in the following table (Table 6).

| Subnucleus | Branch |
|---|---|
| Ventromedial | Cervical |
| Medial | Anterior/posterior auricular |
| Dorsal | Zygomatic-orbital |
| Lateral | Inferior/superior labial |
| Intermediate | Inferior/superior labial |

**Table 6. Subnuclei (five) of facial nucleus in Rabbit (17)**

In pigs, Sus scropha, (18), seven well-definied subnuclei of facial nucleus were identified. The motoneuron pools of the perioral muscles were generally segregated from motoneurons innervating other facial muscles of the rostrum. However, motoneuron pools were not confined to single nuclei, but instead spanned across 3-4 subnuclei. The perioral muscle motoneuron pools overlapped but were organized somatotopically. Motoneuron pools of portions of the superior orbicularis oris overlapped greatly with each other but exhibited a crude somatotopy within the superior orbicularis oris motoneuron pool. The large and somatotopically organized motoneuron pool in pigs suggests that the upper lip might be more richly innervated than the other perioral muscles and functionally divided.

In guinea pigs and rabbits (19), the accessory facial nucleus only innervates the posterior belly of the digastric muscle, while the anterior belly of the digastric muscle is innervated from neurons of the ventromedial part of the motor nucleus of the trigeminal nerve. Additionally, no motoneurons innervating the digastric muscle were found within the main facial nucleus.

The facial motor nucleus in monkeys (20) has a muscolotopic organization and is divided into four different subnuclei: dorsal, medial, intermediate, and lateral (Figure 2; Table 7).

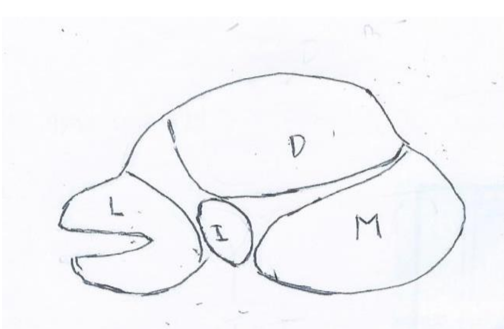


**Figure 2. Facial nucleus of monkey subdivided in subnuclei: D, dorsal; M, medial; L, lateral; I, intermediate. Figure modified from Horta (20).**

| Subnucleus | Muscle |
|---|---|
| Dorsal | Orbicularis oculi |
| Intermediate | Zygomaticus, Platysma |
| Lateral | Orbucularis oris, Buccinator |
| Medial | Auriculaus siperior |

**Table 7. Subnuclei of facial nucleus in Monkey (20).**

Morphologically, the motor facial nucleus at the rostral pole showed few, sometimes scattered cells that belonged to the "dorsal subnucleus." At the rostral level, the "intermediate subnucleus" was generally fused to the dorsal subnucleus, which was the predominant nucleus. The other subnuclei could be identified from rostral pole to caudal pole, all increased in size, and in the middle third reaching the largest area of the cross-section (Figure 3). The caudal pole was formed by a small group of large motoneurons that belonged to the "lateral subnucleus."

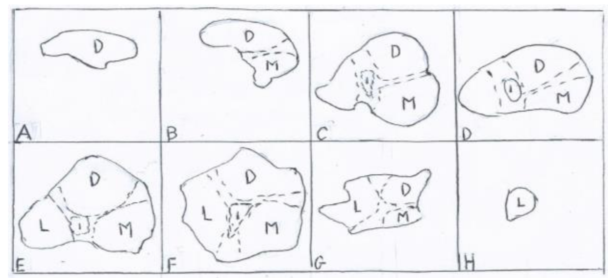


**Figure 3. Facial nucleus of monkey in rostrocaudal direction from A-H; the nucleus is subdivided in the subnuclei: Dor, dorsal; M, medial; L, lateral; I, intermediate. Figure modified from Horta (20).**

The motor facial nucleus, by retrograde labeling patterns, revealed that individual muscles were innervated by six "longitudinal functional columns of motoneurons" (Table 8).

The "longitudinal functional columns" correspond to the individual muscle. The columns of the orbicularis oculi, zygomaticus, orbicularis oris, auricularis superior, buccinator and platysma muscles were located in the dorsal, intermediate, lateral, medial, lateral and intermediate subnuclei respectively, except in the case of the frontalis and levator labii superioris alaeque nasi muscles, whose functional columns occupied more than one cytoarchitectonic subnucleus, thus the motoneuron columns of the levator labii superioris alaeque nasi muscle and frontalis muscle could not be associated with a specific subnucleus.

| *Longitudinal functional column* | *Muscle* | *% of the column with neurons to single muscle* |
|---|---|---|
| Dorsal | Orbicularis oculi superior, inferior | 95 |
| Intermediate | Zygomaticus | 58,4 |
| Lateral | Orbicularis oris | 88,9 |
| Medial | Auricularis superior | 76,8 |
| Lateral | Buccinator | 90 |
| Intermediate | Platysma | 95 |

**Table 8. Columns of facial nucleus in Monkey (left), muscle (center), % of column with labelled neurons for each muscle (right).**

In macaca fascicularis, Welt and Abbs (21) reported that the facial nucleus extended rostrocaudally in the pons for about 2 mm, varying in shape and cross-sectional area along this axis with motoneurons clustered in subnuclei whose boundaries were not sharp - they were not segregated by fiber bundles, and their length, number, and area varied with rostrocaudal location.

Additionally, the AA observed that individual muscles were innervated by longitudinal columns of motoneurons with each muscle region represented at all rostrocaudal levels of its column.

The columns began at different rostrocaudal levels and varied in length. Columns for closely related muscles, such as the orbicularis oris and mentalis of the lower lip, tended to overlap, whereas columns for disparate muscles, such as the perioral and orbital, did not overlap. Most motoneurons have the dendritic processes branched extensively among several different columns or subnuclei, and some dendrites extended outside of the nucleus into the surrounding tegmentum. Mean soma diameter (10.4-42.2 microns) was distributed unimodally, reflecting the absence of gamma motoneurons and lack of muscle spindles in the facial muscles. Large and small motoneurons were found in all regions of the nucleus, but the largest ones were located caudally and innervated muscles of the upper and lower lip.

The perioral muscles also had more neurons, longer columns, and a lower cell density than the other muscle groups examined. These features may reflect the functions of the perioral muscles in facial expression and vocalization.

In humans (1), the facial nerve is a mixed nerve containing both sensory and motor fibers.

1) The sensory fibers transmit touch, pain, and pressure information from the tongue, pharynx, and skin near the ear canal and information originating from the receptors in the taste buds of the anterior tongue and terminating in the solitary nucleus.

2) The motor facial nerve includes the muscle that closes the eye, moves the lips, and produces facial expressions. The facial nerve provides the efferent limb of the corneal reflex, the trigeminal nerve provides the afferent information from the cornea and facial nerve active in eyelid closure. The visceromotor fibers of the facial nerve originating from the pregangliar parasympathetic neurons are located in the superior salivary nucleus in the reticular formation, posterolaterally to the inferior extremity of the facial nucleus. Some fibers, running along the chorda tympani, arrive at the submandibular ganglion innervating the sublingual and submandibular glands, other fibres running along the major superficial petrosal nerve arrive at the pterigolapaltine ganglion innervating the nasal and palatine glands.

The somatoneuron fibers of the facial nerve originate from the motor nucleus situated in the caudal portion of the ventrolateral pontine tegmentum. Its axons take an unusual course, traveling dorsally and looping around the abducens nucleus, where they form the facial colliculus at the base of the fourth ventricle, they travel along the ventral pons, medially to the spinal trigeminal nucleus, and emerge from the bulbo-pontine sulcus. It was demonstrated that the facial motor nucleus (5) has a dorsal and ventral region: the neurons in the dorsal region innervate the muscles of the upper face and the neurons in the ventral region innervate the muscles of the lower face.

The literature (22) reported that a 75-year–old male cadaver presented an aberrant nerve branch of the facial nerve, innervating the sternocleidomastoid muscle, in addition to the accessory nerve and cervical rami $C_2$ and $C_3$. The aberrant innervations may occur as results of a fusion of the muscular compartment from digastric and sternocleidomastoid muscles during the development or might be the source of the misinterpretation of the electromyographic findings.

## 5. Facial nucleus development

The somatotopy of the facial nucleus was also identified during the development in opossum (23) and humans. In opossum (Monodelphis domestica), the results suggest that the migration of facial motoneurons to the facial motor nucleus is a postnatal event, the efferent projections from facial and hypoglossal motoneurons project into the peripheral region of their target muscles from the day of birth, and the facial motoneurons migrate to their destination in the brainstem thereafter, in close association with radial glial fibers.

The somatotopy of the facial nucleus was identified by AA **(**24) by immunohistochemistry during development, and it can be subdivided into five structurally discrete regions with various neurotransmitters and neuropeptides in the neurons and nerve fibres of the human facial nucleus at 14 and 27 weeks of gestation and in the neonate. The results showed that whilst choline acetyltransferase-positive neurons were observed in the facial nucleus at all stages of development, dopamine beta-hydroxylase-positive neurons were only found in the neonate. In addition, afferent nerve fibres positive for choline acetyltransferase, enkephalin, and substance P were observed at all stages of development. In the younger specimens, these fibres were evenly distributed, however, in the neonates the fibres were asymmetrically distributed as the different types became concentrated in the various structurally distinct regions of the facial nucleus.

## 6. Discussion

Studies of the facial motor nucleus and the rostrocaudal axis of the facial musculature (18, 20, 23, 25) suggest that a basic pattern of muscle representation exists in nucleus of the facial nerve or VII nucleus that is common to all mammals. As a rule, it is represented along the mediolateral axis of the VII nucleus, whereas the superoinferior axis of the face is represented along the dorsoventral axis of the nucleus (Figure 4).

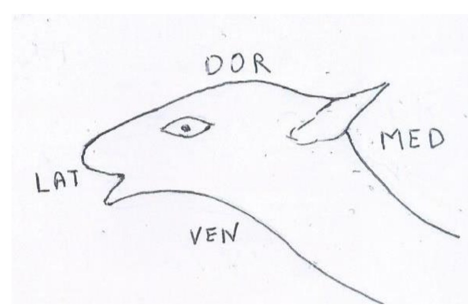


**Figure 4. Facial nucleus of monkey subdivided in subnuclei: Dor, dorsal; Med, medial; Lat, lateral; Ven, Ventral; I, intermediate. Figure modified from Sherwood (25).**

Thus, muscles surrounding the mouth are represented in lateral regions of the VII nucleus, posterior auricular and neck muscles are represented in medial regions, and intermediate neurons innervate muscles around the eyes, the forehead, and anterior auricular muscle.

Like all lower motor neurons, neurons of the facial motor nucleus receive cortical input from the primary motor cortex in the frontal lobe of the brain.

Interestingly, the neurons in the dorsal aspect of the facial motor nucleus receive inputs from both sides of the cortex, while those in the ventral aspect mainly receive contralateral inputs. The result is that both sides of the brain control the muscles of the upper face, while the right side of the brain controls only the lower left side of the face, and the left side of the brain controls only the lower right side of the face. The impairment therefore causes facial asymmetry, since the healthy side is responsible for a contralateral attraction, so that in cases of peripheral impairment, it is homogeneous on the upper face and on the lower face, but it is not accompanied by automatic-voluntary dissociation. In cases of paralysis of the central facial nerve, the deficiency is predominant on the lower part of the face and is accompanied by automatic-voluntary dissociation. Bell's sign corresponds to an automatic upward and outward movement of the eye.

The facial nucleus is integrated in the emotional system: the amygdala receives emotional information which is sent to the widespread cortical and subcortical areas. Recent studies (26) have elucidated the somatotopic representation of the amygdalar output system in the brain of the rhesus monkey and showed that the lateral basal nucleus of the monkey amygdala projects to the cingulate motor cortex M3, and the target cortical neurons project somatotopically to the facial nucleus in the brain stem.

## 7. Conclusions

The basic pattern of muscle representation of the facial nucleus is common to all mammals.

The rostrocaudal axis of the facial musculatureis represented along the mediolateral axis of the nucleus VII, and the superoinferior axis is represented along the dorsoventral axis of the nucleus. Dor. Dorsal;Med. Medial; Lat. Lateral; Ven. Ventral. Figure modified from Sherwood (25).

## References


1. Lundy-Ekman L: Neuroscience. Fundamental for Rehabilitation. 4th Edition. Saunders Elsevier, 2007.
2. Philips CD, Bubash LA: The facial nerve: anatomy and common pathology. Semin Ultrasound CT MR. 2002 Jun;23(3):202-17. doi: 10.1016/s0887-2171(02)90047-8. PMID: 12168997.
3. Martínez Pascual P, Maranillo E, Vázquez T, Simon de Blas C, Lasso JM, Sañudo JR: Extracranial Course of the Facial Nerve Revisited. Anat Rec (Hoboken) Apr; 302(4): 599-608, 2019. doi: 10.1002/ar.23825.
4. Carpenter MB: Human Neuroanatomy seventh edition. The Williams & Wilkins Company. Baltimore, 1976.
5. Gray, 2008: Gray's Anatomy: The Anatomical Basic Basis of Clinical Pratice edited by Standring Susan.
6. Carpenter MB: Human Neuroanatomy seventh edition. The Williams & Wilkins Company. Baltimore,1976.
7. Papez JW: Subdivisions of facial nucleus. J. Comp. Neurol, 64. p. 41-61, 1927.
8. Courville J: The nucleus of facial nerve; the relation between cellular groups and peripheral branches of the nerve. Brain Res 1 (4): 338-54. 1966;
9. Joseph MP, Guinan JJ Jr, Fullerton BC, Norris BE, Kiang NY: Number and distribution of stapedius motoneurons in cats. J Comp Neurol 1985 Feb 1; 232(1): 43-54.
10. Kume M, Uemura M, Matsuda K, Matsushima R, Mizuno N: Topographical representation of peripheral branches of the facial nerve within the facial nucleus: A HRP study in the cat. Neurosci Lett 1978 Apr;8(1): 5-8.
11. Pong M , Horn KM, Gibson AR: Pathways for control of face and neck musculature by the basal ganglia and cerebellum. Brain Res Rev 2008 Aug;58(2): 249-64. doi:10.1016/j. brainresrev.2007.11.006. Epub 2007 Dec 7
12. Martin MR, Lodge D: Morphology of the facial nucleus of the rat. Brain Res. 1977 Mar 4;123(1): 1-12.
13. Colin Dr, Hinrichsen FL, Watson CD: The facial nucleus of the rat: Representation of facial muscles revealed by retrograde transport of horseradish peroxidase. Anat Rec Vol. 209, Issue3. pp. 407-415, 1984.
14. Ashwell KW: The adult mouse facial nerve nucleus: morphology and musculotopic organization. J Anat. 1982 Oct;135(Pt 3): 531-8. PMID: 7153172
15. Uemura-Sumi M, Manabe Y, Matsushima R, Mizuno N: Correlation of the main peripheral branches of the facial nerve with the cytoarchitectonic subdivisions of the facial nucleus in the guinea pig. Anat Embryol (Berl). 1986;174(2):161-6.
16. Reuss SAl-Butmeh S, Riemann R: Motoneurons of the stapedius muscle in the guinea pig middle ear: afferent and efferent transmitters. Brain Res. 2008 Jul 24;1221: 59-66. doi: 11.1016/j.brainres.2008.05.008. Epub 2008 May 15.
17. Satoda T, Takahashi O, Tashiro T, Matsushima R, Uemura-Sumi M, Mizuno N: Somatotopic organization of facial nucleus of rabbit. With particular reference to intranuclear representation of perioral branches of the facial nerve. Anat Anz. 1988;165(2-3): 83-90.
18. Marshall CD, Hsu RH, Herring SW: Somatotopic organization of perioral musculature innervation within the pig, Sus scropha, facial motor nucleus. Brain Behav Evol 2005; 66(1): 22-34. Epub 2005 Apr 8. 2005.
19. Uemura-Sumi M, Satoda T, Tashiro T, Matsushima R, Mizuno N: Re-examination of the topographical distribution of motoneurons innervating the digastric muscle in the rabbit and guinea pig. Anat Anz 1991;173(1): 9-16.
20. Horta-Júnior JAC, Tamega OJ, Cruz-Rizzolo RJ: Cytoarchitecture and musculotopic organization of the facial motor nucleus in Cebus paella monkey J. Anat 2004; 204:175–190.
21. Welt C and Abbs JH: Musculotopic organization of the facial motor nucleus in Macaca fascicularis: a morphometric and retrograde tracing study with cholera toxin B-HRP. J Comp Neurol, 1990 Jan 22;291(4): 621-36. doi: 10.1002/cne.902910409. PMID: 2329193).
22. Cvetko E: Sternocleidomastoid muscle additionally innervated by the facial nerve: case report and review of the literature. Anat Sci Int 2015 Jan; 90(1): 54-6. doi: 10.1007/s12565-013-0224-8. Epub 2013 Dec 18.
23. Swanson JJ, Kuehl-Kovarik MC, Elmquist JK, Sakaguchi DS, Jacobson CD: Development of the facial and hypoglossal motor nuclei in the neonatal Brazilian opossum brain. Brain Res Dev Brain Res. 1999 Feb 5;112(2):159-72.
24. Yew D T, Webb SE, Lam ET: Neurotransmitters and peptides in the developing human facial nucleus Neurosci Lett. 1996 Mar 8;206(1):65-8. doi: 10.1016/0304-3940(96)12435-6.22.

25. Sherwood CC: Comparative Anatomy of the Facial Motor Nucleus in Mammals, With an Analysis of Neuron Numbers in Primates. Anat Rec, Part A 287A:1067–1079; 2005.
26. Yuasa S: Somatotopy in the emotional expression by the amygdale. Brain Nerve 2009 Dec; 61(12):1395-404. PMID: 20034306