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Quantitative Study on the Motor Facial Nucleus.

顔面神経運動核の定量的研究.

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There have been very many research reports on the motor facial nucleus in the past, but as we could ascertain, there have been none on a quantitative study on it. The degree of development of the nucleus has been discussed relying solely on the impressions obtained in examining microscopic sections — a procedure very unsatisfactory from the view-point of comparative anatomy.

So, the present authors attempted a quantitative study of the subject nucleus with the aim of indicating its development by means of precise values. First we counted the number of cells in the right and the left halves of the nucleus of the animals examined on the serial sections and summed up the figures. Such an absolute number of the cells, however, is too sensively subject to the effect of difference of the relative size of the total brain of the animals for the purpose of comparative study. Therefore, we chose the level where the trochlear nerve just depart from the brain stem as representing its standard cross-section, and measured the total area of the tegmentum at this level (including both the right and the left halves) with a planimeter. Then, the ratio of the above absolute number of the nuclear cells to the area of the tegmentum was calculated, to determine the relative unnumber of the nuclear cells for use in the comparative study.

As materials of the study brain specimens of man, 14 *Simiae*, 2 *Prosimiae*, 17 *Carnivora*, 11 *Ungulata*, 3 *Cetacea*, 6 *Rodentia*, 4 *Chiroptera*, 3 *Insectivora*, 9 *Edentata*, 9 *Marsupialia*, 4 *Monotremata* (83 species of mammals in total), domestic fowl (cock and hen), 6 reptiles and a frog (91 species in total) were used. Each specimen consisted of serial PAL-carmin stained transverse sections.

I. Findings and Discussion.

The cutaneous musculature consists of the major part of that covering the trunk and the limbs and that covering the head and the neck. As is well known, the former part is called the panniculus carnosus, while the latter consists only of a m. sphincter colli in lower animals and with the advance of the animal in evolution, this muscle differentiates into the various muscles in the head and the neck. The muscle originally receiving its nerve supply from the subject motor facial nucleus was the m. sphincter colli, which is present in its typical form in the classes of birds and below, but in mammals, is barely observable in *Monotremata* alone, being dif-

ferentiated into the platysma and various face muscles, as stated above, in the higher orders. During the process of the differentiation, the superficial layer of the m. sphincter colli becomes the so-called platysma myoides, which further dif-

Fig. 1. Relative cell-number of the motor facial nucleus.

ferentiates into the many face muscles, while its deeper layer differentiates chiefly into the cutaneous muscles concerned with the mouth, as already described in past literature.

Tab. 1.

Order and Species		Ncl. orig. N. facialis		
		Area of brain stem (mm ²)	Absolute cell-number	Relative cell-number
1	Homo	159.4	12070	75.7
<i>Simiae</i>	a) Catarrhini			
	2 Macacus inuus	49.0	9900	202.0
	3 Cercopithecus aethiops	41.4	8340	201.4
	4 Cynocephalus hamadryas	88.6	12068	137.0
	5 Hylobates syndactylus	44.6	5872	131.6
	6 Lophocebus albigena	42.9	4048	94.3
	7 Semnopithecus entellus	67.3	5800	86.1
	8 Presbytis entellus	69.6	5980	85.9
	9 Colobus caudatus	70.4	5500	78.1
	b) Platyrrhini			
	10 Saimiri sciurea	34.2	4116	120.3
	11 Ateles paniscus	51.6	5724	110.9
	12 Callithrix jacchus	22.5	2424	107.7
	13 Cebus capucinus	79.6	7670	96.3
	14 Aotes trivergatus	43.2	2120	49.0
	15 Mycetes niger	82.1	3844	46.8
<i>Prosimiae</i>	16 Stenops gracilis	17.3	6356	367.3
	17 Tarsius tarsier	22.6	4964	220.6
<i>Carnivora</i>	18 Nyctereutes procyonoides viverrinus	51.0	14244	279.2
	19 Mustela lutreola	19.3	5302	274.7
	20 Herpetes mungo	32.8	8348	254.5
	21 Nasua nasica	58.1	13216	227.4
	22 Mellivora ratellus	48.2	9876	204.8
	23 Felis catus	56.0	10252	187.8
	24 Gulo luscus	48.4	7250	149.7
	25 Felis leo	157.0	22800	145.2
	26 Meles anakuma	59.8	7908	132.2
	27 Procyon lotor	68.8	8916	129.5
	28 Paradoxurus larvatus	81.6	10428	127.7
	29 Felis pardus	127.2	15676	127.3
	30 Vulpes vulpes japonica	69.0	8440	122.3
	31 Ursus thibetanus japonicus	110.0	13280	120.7
	32 Euhya lutris	120.2	13612	113.2
	33 Phoca vitulina	116.0	10552	90.9
	34 Otaria ursina	118.4	7702	65.0

<i>Ungulata</i>	35	Porcus babirusa	65.0	18400	283.0
	36	Tragulus kanchil	47.5	12686	267.0
	37	Cervus nippon	139.0	29644	213.2
	38	Equus hemionus	170.7	30800	180.4
	39	Bos grunniens grunniens	176.5	29492	167.0
	40	Bos bubalis	223.2	35536	159.1
	41	Camelopardalis giraffa	77.5	12276	158.4
	42	Hippopotamus amphibius	221.0	34112	154.3
	43	Ovis aries	125.0	18690	149.5
	44	Camelus bactrianus	195.0	26620	136.5
	45	Equus caballus	283.2	31700	111.9
<i>Cetacea</i>	46	Balaena sieboldii	267.5	73390	274.3
	47	Delphinus longirostris	226.5	55956	247.0
	48	Balaenoptera borealis	581.5	72824	125.2
<i>Rodentia</i>	49	Pteromys momonga	20.9	9620	460.2
	50	Rattus norvegicus	19.4	8396	432.7
	51	Dasyprocta aguti	38.1	9792	257.0
	52	Hystrix cristata	78.9	16020	205.0
	53	Lepus cuniculus	51.8	10592	204.4
	54	Pteromys leucogenys	33.2	7822	135.6
<i>Chiroptera</i>	55	Desmodus rufus	6.0	5428	904.6
	56	Rhinolophus fertum-equinum npipon	9.7	6292	648.6
	57	Harpiocephalus leucogastra	19.3	8644	447.8
	58	Pteropus giganteus	21.2	3618	170.6
<i>Insectivora</i>	59	Talpa micrura	13.3	4370	328.5
	60	Erinaceus dealbatus orientalis	21.8	6664	305.6
	61	Sorex caeruleus	34.5	6660	193.0
<i>Edentata</i>	62	Bradypus tridactylus	17.2	6648	386.5
	63	Dasybus sexcinctus	40.4	6736	166.7
	64	Manis pentadactyla	42.4	5604	132.1
	65	Manis tetradactyla	41.8	4910	117.4
	66	Manis tricuspis	37.6	4184	111.2
	67	Tatusia novemcinctus	49.6	4246	85.6
	68	Myrmecophaga jubata	48.6	4060	83.5
	69	Tolypeutes tricinctus	50.5	3988	78.9
	70	Choloepus didactylus	65.6	4480	68.2
<i>Marsupialia</i>	71	Vombatus hirsutus	39.5	20024	512.4
	72	Didelphis virginiana virginiana	17.3	7476	432.1
	73	Dasyurus viverrinus	22.4	7540	336.6
	74	Dendrolagus ursinus	39.7	8628	217.3
	75	Myrmecobius fasciatus	33.7	6824	202.4

	76	<i>Didelphis marsupialis</i>	38.0	6728	177.0
	77	<i>Macropus ruficollis bennettii</i>	71.7	11732	163.6
	78	<i>Macropus giganteus</i>	96.8	13938	143.9
	79	<i>Sacrophilus ursinus</i>	75.0	7256	96.7
<i>Monotremata</i>	80	<i>Echidna aculeata typica</i>	30.0	5096	169.8
	81	<i>Proechidna bruijnii</i>	31.2	4814	154.2
	82	<i>Ornithorhynchus anatinus</i>	39.4	5018	127.3
	83	<i>Echidna aculeata setosa</i>	33.0	3764	114.0
<i>Aves</i>	84	<i>Gallus domesticus</i> ♂	24.0	2860	119.1
		<i>Gallus domesticus</i> ♀	22.0	2592	117.8
<i>Reptilia</i>	85	<i>Python reticulatus</i>	15.0	1416	94.4
	86	<i>Chamaeleon basiliscus</i>	17.0	1530	90.0
	87	<i>Caiman sclerops</i>	38.0	3380	88.9
	88	<i>Alligator mississippiensis</i>	43.0	3288	76.4
	89	<i>Varanus salvator</i>	21.0	1340	63.8
	90	<i>Caiman niger</i>	45.0	2820	62.6
<i>Amphibia</i>	91	<i>Rana nigromaculata</i>	2.0	114	54.0

Now, according to VERSLUYS, the dorsal part of the facialis-constrictor is said to be well developed in *Amphibia* and *Sauropsida*, but KAPPERS says that the muscles innervated by the facial nerves are still very simple in reptiles and birds and form an elaborate system only in mammals.

Our findings showed good agreement with the opinion of KAPPERS, for the absolute as well as the relative numbers of the cells of the facial nucleus in birds, reptiles and frog were very low (Fig. 1 and Tab. 1). This naturally means that the musculature supplied from the motor facial nucleus is very poorly developed in these lower animals.

In the mammals, the relative number of the cells in the motor facial nucleus was found generally much larger than that in the non-mammalian animals, vividly indicating that the facialis musculature suddenly gains in development upon passing over from birds to mammals.

Concerning the *Monotremata*, BRONN says that in *Echidna*, all the cutaneous muscles are especially well developed and KAPPERS says that the facial nucleus is large owing to the marked development of the musculature supplied with facial nerves, but according to what we have observed, the relative number of the nuclear cells in *Echidna* is somewhat larger than that in birds, reptiles and frog, but not at all exceptionally large and as an order, the *Monotremata* may be ranked in the group of generally rather low-developed facial nucleus. The *Echidna*, having spines on their surface, may probably have a well-developed panniculus carnosus but the cutaneous musculature receiving nervous supply from the facial nucleus cannot be very well developed. The *Edentata* (except the three-toed sloth) also showed low relative number of cells.

In the mammals other than the *Monotremata*, as shown in Fig. 1 and Tab. 1, the *Marsupialia*, the *Insectivora*, the *Chiroptera* and the *Rodentia* generally showed large relative numbers of the cells, and the *Chiroptera* (except the *Pteropus giganteus*) showed particularly high development of the nucleus. The bats have muscles innervated by the facial nerves in their propatagium, and it may be inferred that these muscles are of high importance in their flying, so that the facial nucleus concerned with the muscles is particularly well developed in them. *Pteromys momonga* and *Pteromys leucogenys* are similarly provided with patagia, but only with plagiopatagia stretched between the fore- and the hind-limbs but no propatagium, and the facial nucleus is far worse developed than in the *Chiroptera*, especially in the latter *Pteromys*. Generally speaking, in the mammals of the lower orders the cutaneous musculature is well developed, and especially well developed in the animals having the habit of curling up their body, as is well known. In Fig. 1 and Tab. 1 we see that the porcupine, the *Erinaceus* and the *Armadillo*, the representative curl-up animals, have not very large relative cell number of the facial nucleus, the number being not the largest among the animals of the same order. This shows that the development of the cutaneous muscles in the body trunk and that of the muscles of the head and the neck do not necessarily run abreast. The generally observed good development of the facial nucleus in *Rodentia*, *Chiroptera*, *Insectivora* and *Marsupialia*, as stated above, may be considered as due to the very high development of the platysma myoides, while the m. sphincter colli has already degenerated off its original form and the face muscles are as yet not sufficiently developed as mimic muscles. In particular, such a finding may facilitate the understanding of the rather large relative number of cells shown by the mole and the rat animals which live in narrow burrows and for whom contracting the bulk of the body to the smallest volume possible is an advantage.

As a mammal rises higher in the stage of evolution, the panniculus carnosus gradually loses in development and nearly disappears in *Simiae* and man. At the same time, as stated above, the sphincter colli in the higher mammals loses their original sphincteric form and differentiate into the various muscles in the neck and the head. In this course of differentiation, the platysma still developed in the neck in the place of the sphincter colli in the lower mammals gradually degenerates while the face muscles become better and better developed in the higher mammals. These face muscles of course play the parts of mimic muscles and actively participate in the expression of emotion, especially well in man and *simiae*.

According to our measurements, the motor facial nucleus is moderately developed in *Cetacea*, *Ungulata*, *Carnivora* and *Prosimiae*, but in *Simiae*, it is generally very weak and conspicuously ill-developed in man (Fig. 1 and Tab. 1).

Thus, as the motor facial nucleus was found relatively very small in *Simiae* and man with the face muscles extremely well developed as mimic muscles but with the platysma fallen into degeneration, but very well developed in the lower mammals with the face musculature and platysma developed in the reverse direction, it may be clearly inferred that the development of the facial nucleus depends more on the degree of development of the platysma rather than that of the facial musculature, perhaps on the relative quantitative development of the two.

II. Summary.

1. The relative development of the motor facial nucleus was studied, using brain specimens of 91 species of animals, including 83 mammals, the domestic fowl (cock and hen), 6 reptiles and a frog.

2. The relative development of the nucleus was determined by the ratio of the total number of the cells in the right and the left halves of the nucleus counted on the serial transverse sections of the above specimens to the area of the tegmentum of the brain stem at a certain level.

3. In the non-mammalian animals, the relative number of the cells in the motor facial nucleus is very small.

4. The relative number in the mammals was small in the order of *Monotremata*, generally large in *Marsupialia*, *Insectivora*, *Chiroptera* and *Rodentia* and moderately large in *Cetacea*, *Ungulata*, *Carnivora* and *Prosimiae*. In higher *Primates* it is small and particularly small in man. In *Edentata* also it is generally small.

5. A comparative study of the findings has revealed that the development of the motor facial nucleus depends more on the development of the platysma than on that of the face musculature.

In conclusion, I hasten to express my thanks to Prof. URA and Asst. Prof. YAMAMOTO of this laboratory for their kind assistance and valuable suggestions.

著 者 自 抄.

著者等は顔面神経運動核の相対的発達を調べて之を比較解剖学的に検討し、本核の発達の相異は主にどの筋と関係あるかを追究する為に本研究をなした。

材料として83種哺乳動物、鶏、6種爬虫類及び蛙、総計91種動物脳の横断連続切片標本を用いた。

本核の相対的発達を知る為に我々は左右両半の本核細胞の総数を数え、此総数の1定脳幹部被蓋横断面積に対する比を求めた(対比值)。

その結果、鳥類以下の動物に於ては此対比值が極めて小さい。哺乳類に於ては単孔目では小さいが、有袋目、食虫目、翼手目及び嚙歯目では一般に大きく、鯨目、有蹄目、食肉目及び擬猴目では中等大である。霊長目でも小さいが人では殊に小さく、食歯目でも亦大部分小さい。

此顔面神経核細胞数の対比值と各種動物に於ける顔面神経支配筋の分化発達の相違とを比較検討した結果、顔面神経運動核の相対的発達は顔面筋の発達如何よりは platysma の発達の相違に、より多く関係している事が明かである。

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