FOURTH PRINTING

ATLASES OF THE SPINAL CORD AND BRAINSTEM AND THE FOREBRAIN

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ATLAS I

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ACKNOWLEDGMENT

The 16 sections which comprise the forebrain atlas are modified from photographs of the "Atlas Anatomicum Cerebri Humani" of Prof. G. Jelgersma (published by Scheltema & Holkema's Boekhandel & Uitgevers MIJ n.v.-Amsterdam).

INTRODUCTION

Two atlases of sections are presented, one of the spinal cord and brainstem, the other of the forebrain. In addition, two key figures are included to show the level of each section in the neural axis.

THE SPINAL CORD-BRAINSTEM ATLAS. The spinal cord-brainstem atlas is a composite atlas made up of 36 selected transverse sections of an average sized adult cord and brainstem.

The illustrations are four times the natural size and were made from photographs of sections prepared, for the most part, by the Pal-Weigert method. The first 6 sections are through the spinal cord; the remaining 30 through the brainstem. Sections 1-7, 9, and 12-15 are from the collection of Dr. Lewis Stevenson; 16-36 are from the collection of Dr. Adolf Meyer. The level and plane of each section are shown in key Figure 53. The sequence of the sections is from below up, from the spinal cord through the brainstem. By means of this arrangement and in conjunction with Figure 53, the location and extent of the various nuclei can be established and the fiber systems easily followed in their ascent or descent through the cord and brainstem.

In each drawing the right and left sides of the section conform to the corresponding labelling in section 1; in addition, the midline is indicated by two lines on the outside of the section: one dorsal, the other ventral. Outlined heavily in black in each section is the motor plate. The latter is so emphasized because it is the oldest part of the central nervous system and constitutes the central core around which the rest of the nervous system develops and can be reconstructed. The motor plate in the brainstem comprises most of the reticular substance; in the cord, the ventral and lateral horns.

THE FOREBRAIN ATLAS. The 16 sections which comprise the forebrain atlas are cut in a frontal plane through the right cerebral hemisphere. They were drawn from the corresponding photographs of the "Atlas Anatomicum Cerebri Humani" of Prof. Dr. G. Jelgersma (Published by Scheltema & Holkema's Boekhandel & Uitgevers MIJ n.v.-Amsterdam). The correlation between the figures of the forebrain atlas and the sections of the Jelgersma atlas (the numbers of which are indicated in parentheses) is as follows: 37 (3); 38 (4); 39 (5); 40 (6); 41 (8); 42 (10); 43 (13); 44 (19); 45 (24); 46 (29); 47 (34); 48 (37); 49 (40); 50 (41); 51 (42); 52 (44).

The illustrations are enlarged four times the natural size. Each one is accompanied by an inset showing the outline of the whole section and

the part from which the drawings were made. The midline of each section is indicated by an arrow. The level and plane of each section are shown in key Figure 54.

THE STUDY OF THE ATLASES AND THE RECONSTRUCTION OF THE NERVOUS SYSTEM. Since the atlas illustrations are all to the same scale (x4), the relative size, shape and position of the various nuclei and fiber systems are accurately retained throughout. As a result, the illustrations can also be used as the basis for a reconstruction of the nervous system and thus provide a three-dimensional visualization of these structures. The method of reconstruction was described by Meyer and Hausman. (Meyer, Adolf & Hausman, Louis: A Reconstruction Course in the Functional Anatomy of the Nervous System, Arch. Neurol. & Psychiat., March, 1922, Vol. VII, pp. 287-310; Meyer, Adolf & Hausman, Louis: The Forebrain: A Study and Reconstruction Based on the Method Outlined by the Authors, Arch. Neurol. & Psychiat., April, 1928, Vol. 19, pp. 573-593.*)

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* Based on this method, a manual with detailed instructions for the use of the atlas sections in the reconstruction of the nervous system is in the process of preparation.

According to this method the various neural systems are considered and analyzed in a definite sequence, one which closely follows the phylogenetic and embryologic development of the nervous system. The method makes use of the fundamental principle that the nervous system is put down in layers very much like the concentric circles in the trunk of a tree. The old layers appear in or near the center of the nervous system and form its central core. The new layers develop around this central core; in keeping with their phylogenetic development they appear more and more towards the periphery of the central nervous system, the most recently acquired structure, that is, the cerebral cortex or bark, appearing at the surface of the brain. Therefore, when the nervous system is reconstructed, it is logically and conveniently built from the inside out.

In studying the atlas sections or in reconstructing the nervous system, the same approach is used. The old structures are considered first. They comprise the peripheral afferent and efferent cerebrospinal nerves and their cells of origin in the receptor and motor plates respectively. The receptor plate constitutes the cerebrospinal ganglia; the motor plate the ventral and lateral horns of the cord and most of the reticular substance of the brainstem. These structures constitute the segmental nervous system.

The new structures are taken up next. They comprise the suprasegmental nervous system, namely, the cerebellum, the colliculi, and the forebrain, and their afferent and efferent connections with the segmental nervous system.

The atlases and key figures furnish the architectural blue-prints for the reconstruction of the nervous system. In the preparation of this material, the clinical application has been constantly kept in mind. For example, the plan of the reconstruction arbitrarily provides for the left side of the body and since the latter is controlled by the opposite cerebral hemisphere, the right side of the brain, therefore, is built. For that reason the sections of the forebrain atlas are through the right cerebral hemisphere.

As to the cord and brainstem, both sides are reconstructed since so many of the pathways are bilaterally represented in these parts. In the sections of the cord-brainstem atlas, the nuclei and tracts are indicated in keeping with this representation. In many instances these structures are indicated on both sides, not only for anatomical and clinical reasons, but also to aid in the orientation of adjacent parts. In instances where tracts intermingle or overlap, the representation is semi-schematic.

THE COLOR SCHEME. A definite color scheme is used in studying the atlases and reconstructing the nervous system. It is designed to correlate structure with function. Those structures having the same connections and functions are represented by the same color. For example, the afferent cerebellar systems are represented in yellow; the efferent in brown. When two shades of a given color are used, the darker shade represents the older structure phylogenetically; the lighter the more recently acquired system. For example, the old cerebellum is represented in dark yellow and dark brown; the new, in light yellow and light brown.

The following color scheme is used for both the reconstruction of the nervous system (in clay and wire), and the study of the atlases;

Red : The efferent segmental systems (the efferent cerebrospinal nerves and their cells of origin in the motor plate).

Blue : The afferent segmental systems (the afferent cerebrospinal nerves and their cells of origin in the receptor plate, i.e., cerebrospinal ganglia).

Gray	: The intra- and intersegmental systems and the reticular gray.
Yellow (dark)	: The old afferent cerebellar systems (Stages I and II).
Yellow (light)	: The new afferent cerebellar system (Stage III).
Brown (dark)	: The old efferent cerebellar systems (Stages I and II).
Brown (light)	: The new efferent cerebellar system (Stage III).
Violet	: The suprasegmental auditory system, including the inferior colliculi.
Purple	: The superior colliculi and the corresponding tectospinal systems.
Green (dark)	: The old afferent cerebral systems (such as the lateral spinothalamic).
Green (light)	: The new afferent cerebral systems (such as the medial lemniscus and ventral spinothalamic).
Carmine	: The efferent cerebral systems (pyramidal, such as the corticospinal).
Pink	: The efferent cerebral systems (extrapyramidal, such as the corpus striatum, etc.).
Orange	: The suprasegmental olfactory system.

The illustrations are printed on paper that will take the color of any of the standard pencils. It is well to color each system as it is studied and traced through the various sections before reconstructing it. In this way the sections are built up with the model of the nervous system and a better understanding provided for both.

THE ATLAS LABELS. Each atlas is provided with a list of abbreviations. The abbreviations were planned to suggest as much as possible the word itself so as to simplify the identification of the labels. Where space permits the entire word is used. For convenience, a few specific symbols are employed.

BRAIN RECONSTRUCTION KIT. To aid in the technical reconstruction of the nervous system, a brain reconstruction kit is provided by Clay-Adams Co., Inc. (141 East 25 Street, New York City 10). This kit contains the framework of the reconstruction, as well as the necessary clay, wire, and other accessories.

I am greatly indebted to Miss Zelda Oser for the painstaking care with which she has executed the drawings and arranged the labelling.

LIST OF ABBREVIATIONS OF SPINAL CORD-BRAINSTEM ATLAS

SYMBOLS

X Decussation

Wooden midline symbol which, in the reconstruction of the nervous system, is used to represent a midline sagittal section through the cerebellum and colliculi. The abbreviation for this symbol appears in section 16-36. Although in the reconstruction the wooden symbol is incorporated within the section, in the atlas it is represented only in relative position on the outside of the section in order not to alter the natural appearance of the latter.

NUMERALS

III Oculomotor
IV Trochlear
V Trigeminal
VI Abducens
VII Facial
IX Glossopharyngeal
X Vagus
XII Hypoglossal

ABBREVIATIONS

Acc. cun. nu.	accessory cuneate nucleus
Aff.	afferent
Aff. N.V	afferent division of trigeminal nerve
AHB	anterior hindbrain segment
Amyg.	amygdala of the cerebellum
Ant.	anterior
AP	association plate
AP (d.h.)	association plate (dorsal horn of spinal cord)
AP ret. fm.	association plate, reticular formation of brainstem
Aq. S.	aqueduct of Sylvius
b.	body
Brach. inf. coll.	brachium inferior colliculus
Cbll.	cerebellum
Cent. Canal	central canal
Cen. teg. t.	central tegmental tract
Central teg. t., etc.	central tegmental tract, tegmento-olivary fibers
Ch.	chorioid plexus
C.I.R.L.	retro-lenticular limb of internal capsule
Coch.	cochlear
Coll.	colliculus
Com.	commissure
Com. sol. nu.	commissure of solitary nucleus or commissural nucleus of vagus nerve
Cor. ponbulb.	corpus pontobulbare
Corpus ponbulb.	corpus pontobulbare
Crossed N. IV	crossed trochlear nerve
Crossing tsp. fb.	crossing tectospinal fibers
C. teg. t.	central tegmental tract
D.	dorsal
D.X	dorsal nucleus of vagus nerve
D. cornucom. nu.	dorsal cornucommissural nucleus
Desc. rt. troch. N.	descending root trochlear nerve
D. f. proprius	dorsal fasciculus proprius
D. glph. nu.	dorsal glossopharyngeal nucleus
Dlat.	dorsolateral

Dlat. oclm. nu.	dorsolateral division of oculomotor nucleus
Dm.	dorsomedian nucleus of ventral horn
Dmarg. nu.	dorsomarginal nucleus
Dmedian nu.	dorsomedian nucleus
Dorso-pontine nu. + fb.	dorso-pontine nuclei and fibers
D. pon. nu.	dorsal pontine nuclei
D. rt. m. div.	medial division of dorsal root
D. spcbll. t.	dorsal spinocerebellar tract
D. teg.	dorsal tegmental decussation or decussation of tectospinal tracts
Edinger Wes. nu.	Edinger Westphal nucleus
Eff.	efferent
Eff. N.V	efferent division of trigeminal nerve
Eff. trig. nu.	efferent nucleus of trigeminal nerve
Emb. nu.	emboliform nucleus
4th V.	fourth ventricle
F.	fasciculus
F. cun.	fasciculus cuneatus
F. dlat.	fasciculus dorsolateralis
F. grac.	fasciculus gracilis
fac. nu.	facial nucleus
fb.	fiber or fibers
Fld.	fasciculus longitudinalis dorsalis
Floc. ped.	peduncle of the flocculus
fm.	formation
Fronto-pontine fb.	fronto-pontine fibers
Genic.	geniculate body
Genu VII	genu of the facial nerve
Glob. nu.	globose nucleus
Glph. N.	glossopharyngeal nerve
Gust. nu. + t.	gustatory nucleus and tract
Haben. ped. fb.	habenulo-peduncular fibers
Hilus Inf. Ol.	hilus of the inferior olive
Hypogl. N.	hypoglossal nerve
Hypogl. nu.	hypoglossal nucleus
Hypogl. rt.	hypoglossal root
I.	inferior
Inf.	inferior
Inf. intermlat. nu.	inferior intermedio-lateral nucleus
Inf. olive (neo)	new inferior olive or principal olive
Inf. olive (paleo)	old inferior olive or accessory olive
Inf. ves. nu.	inferior vestibular nucleus
Inner cbll. ped.	inner cerebellar peduncle
Intermm. nu.	intermedio-medial nucleus
Interped. fossa	interpeduncular fossa
Interped. gn.	interpeduncular ganglion
Ipd. gn.	interpeduncular ganglion
L.	lateral
L. f. proprius	lateral faciculus proprius
L. pon. nu.	lateral pontine nuclei
L. pontine nu.	lateral pontine nuclei
L. pyr. t.	lateral pyramidal tract
L. retic. nu.	lateral reticular nucleus
L. spth. + spt. t.	lateral spinothalamic and spinotectal tract
L. ves. nu.	lateral vestibular nucleus
L. vessp. t.	lateral vestibulospinal tract
Lat.	lateral
Lat. lemniscus + nu. LL	lateral lemniscus and nucleus of lateral lemniscus

Lat. sup. central nu.	lateral superior central nucleus
LL .	lateral lemniscus
L.Z.	lateral zone adjacent to lateral geniculate
M.	medial
M. cortibulb. fb.	medial corticobulbar fibers
M. genic.	medial geniculate body
M. oculomotor nu.	medial division of oculomotor nucleus
M. ves. nu.	medial vestibular nucleus
Mesenceph. nu. + rt.	mesencephalic nucleus and root of the trigeminal nerve
MHB	middle hindbrain segment
ML	medial lemniscus
MLF	medial longitudinal fasciculus
ML int. arc. fb.	internal arcuate fibers of medial lemniscus
MP	motor plate
MP ret. fm.	reticular formation of the motor plate of the brainstem
MP (v.h.)	ventral horn of motor plate of cord
N.	nerve
N. III	oculomotor nerve
N. VI	abducens nerve
N. VII	facial nerve
N. IX	glossopharyngeal nerve
nu.	nucleus or nuclei
nu. VI	nucleus of abducens nerve
nu. cun.	nucleus cuneatus
nu. emin. ter.	nucleus eminentiae teretis
nu. grac.	nucleus gracilis
nu. intercal.	nucleus intercalatus
nu. LL	nucleus of the lateral lemniscus
nu. param. d.	nucleus paramedianus dorsalis
nu. prepos.	nucleus prepositus
nu. rest. b.	nucleus of restiform body
Olcbll. fb.	olivocerebellar fibers
Olivocbll. fb.	olivocerebellar fibers
Olsp. t.	olivospinal tract
P.	posterior
P. com. nu.	nucleus of posterior commissure
P. med. velum	posterior medullary velum
Parieto-pont. t.	parieto-pontine tract
Perf. subst.	perforated substance
Periped. nu.	peripeduncular nucleus
PHB	posterior hindbrain segment
Pontocbll. fb.	pontocerebellar fibers
Post.	posterior
Prin. nu. V	principal or main sensory nucleus of the trigeminal nerve
Pyr.	pyramid or pyramidal
Rdlat. nu.	retro-dorso-lateral nucleus
Ret. fm.	reticular formation
Retic. cells of AP	reticular cells of association plate
Reticular subst.	reticular substance
Rt.	root
Rubrosp. t.	rubrospinal tract
S.	superior
S.C. nu.	superior central nucleus
S. intermlat. nu.	superior intermediolateral nucleus
S. ol.	superior olive
Sol.	solitary
Sol. nu. + t.	solitary nucleus and tract
Sol. t. + D.	solitary tract and dorsal afferent nucleus of vagus nerve

Sol. t. + V.	solitary tract and ventral afferent nucleus of vagus nerve or nucleus of fasciculus solitarius
Sp. acc.	spinal accessory
Spcbll. nu. or dorsal nu.	spinocerebellar nucleus or dorsal nucleus
Sp. nu. V	nucleus of spinal tract of trigeminal nerve
Sp. nu. + t. Trig. N.	spinal nucleus and tract of trigeminal nerve
Sp. t. V	spinal tract of trigeminal nerve
Spth.	spinothalamic
Spth. + spt. nu. (nu. prop. cornud.)	spinothalamic and spinotectal nucleus or nucleus proprius of dorsal horn
Subst.	substance or substantia
Subst. gel.	substantia gelatinosa
Sulcomarg. t.	sulcomarginal tract
Su. lim.	sulcus limitans
Sup.	superior
Sup. cbll. ped.	superior cerebellar peduncles or brachium conjunctivum
Sup. + inner cbll. ped.	superior and inner cerebellar peduncles
Sup. sal. nu.	superior salivary nucleus
Suprasp. nu.	supraspinal nucleus
t.	tract
T. ch.	tela chorioidea of fourth ventricle
Tectosp. t.	tectospinal tract
Temporo-pont. t.	temporo-pontine tract
Trap. fb.	trapezoid fibers
Trig. rt.	root of trigeminal nerve
trigth.	trigeminothalamic
Trig. thal. fb.	trigeminothalamic fibers
Tsp.	tectospinal
Uv.	uvula
V.	ventral
V. arc. nu.	ventral arcuate nucleus
V. coch. nu	ventral cochlear nucleus
V. cornucom. nu.	ventral cornucommissural nucleus
V. ext. arc. fb.	ventral external arcuate fibers
V. f. proprius	ventral fasciculus proprius
V. glph. nu. (ambig.)	ventral nucleus of glossopharyngeal nerve or upper pole of ambiguus nucleus
V. pon. nu.	ventral pontine nuclei
V. pyr. t.	ventral pyramidal tract
V. spcbll. t.	ventral spinocerebellar tract
V. spth. t.	ventral spinothalamic tract
V. vagus. nu.	ventral nucleus of vagus nerve or ambiguus nucleus
V. vessp. t.	ventral vestibulospinal tract
Vlat.	ventrolateral
Vlat. oclm. nu.	ventrolateral nucleus of oculomotor nerve
Vlat. sulcus	ventrolateral sulcus
Vm.	ventromedian nucleus of ventral horn
Vmedian nu.	ventromedian nucleus

LIST OF ABBREVIATIONS OF FOREBRAIN ATLAS

Amyg. nu.	amygdaloid nucleus
Ansa lent.	ansa lenticularis
Ant. comm.	anterior commissure
Ant. nu. thalamus	anterior nucleus of thalamus
Ant. perf. subst.	anterior perforated substance
Ant. thal. ped.	anterior thalamic peduncle
Brach. inf. collic.	brachium of inferior colliculus
Caps.	capsule
Ch. pl.	chorioid plexus
CIA	anterior limb of internal capsule
CIRL	retrolenticular limb of internal capsule
CISL	sublenticular limb of internal capsule
Comm. sup. collic.	commissure of superior colliculi
Decuss. sup. cbll. ped.	decussation of superior cerebellar peduncle
Dlat. nu. thalamus	dorsolateral nucleus of thalamus
Dm. hypoth.	dorsomedian nucleus of hypothalamus
Eff. pall. fb.	efferent pallidal fibers
Ext. sag. layer	external sagittal layer
F.	fasciculus
Fasc.	fasciculus
Fb.	fiber or fibers
F. lent.	fasciculus lenticularis
G.	gyrus
Genic.	geniculo- or geniculate
Gn. habenulae	ganglion habenulae
H	tegmental field H
H1	tegmental field H1
H2	tegmental field H2
Habenulo-ped. tr.	habenulo-peduncular tract
Hypoth.	hypothalamic or hypothalamus
IGF	isthmus of gyrus fornicatus
Innom. subst.	innominate substance
Int. sag. layer	internal sagittal layer
Lam. t.	lamina terminalis
L. olf. st.	lateral olfactory stria
Lat. gen.	lateral geniculate body
Lat. hypoth.	lateral hypothalamic region
Lat. mamm. nu.	lateral mammillary nucleus
Lat. post. nu. thalamus	lateral posterior nucleus of thalamus
Lat. retic. nu. th.	lateral reticular nucleus of thalamus
M. lem.	medial lemniscus
Mamm.	mammillary or mammillo
Massa int.	massa intermedia
Mamm. th. tract	mammillo-thalamic tract
Nu.	nucleus
Olf.	olfactory
Pallido-hypoth. t.	pallido-hypothalamic tract
Parafasc. nu.	parafascicular nucleus
Paraten. m. nu.	paratenial medial nucleus
Paravent.	paraventricular nucleus
Ped.	peduncle
Pelluc.	pellucidum
Perivent.	periventricular
Pl.	plexus
Post. comm.	posterior commissure
Post. hypoth.	posterior hypothalamic nucleus
Rad.	radiation

Reg.	region
Rostral th. ped.	rostral thalamic peduncle
SO	supraoptic nucleus
St. m. th.	stria medullaris of thalamus
St. med. th.	stria medullaris of thalamus
St. term.	stria terminalis
Strat. zonale	stratum zonale of thalamus
Subep.	subependymal
Subst. nigra	substantia nigra
Sup. cbll. ped.	superior cerebellar peduncle
Sup. occ. fr. fasc.	superior occipito-frontal fasciculus
Supracall. g.	supracallosal gyrus
Teg.	tegmental
Tenia th.	tenia of thalamus
Term. vein	terminal vein
Th.	thalamic
Th. ped.	thalamic peduncle
Thal. fasc. (Hl)	thalamic fasciculus or tegmental field Hl
Thalamic rad.	thalamic radiation of red nucleus
Vent. III	third ventricle
Vent. teg. area	ventral tegmental area
Vlat. nu. thalamus	ventrolateral nucleus of thalamus
Vm. hypoth.	ventromedian nucleus of hypothalamus
V. post. lat. nu. thalamus	ventral postero-lateral nucleus of thalamus
V. thalamic ped.	ventral thalamic peduncle