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Review article

Mini-atlas of the marmoset brain

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ABSTRACT

A mini-atlas of the brain is designed to help students and young researchers who are not familiar with neuroanatomy. In the mini-atlas, a limited number of important nuclei and fiber tracts are shown on a small number of brain sections from posterior end to the anterior end of the brain. The first mini-atlas was introduced for the rat brain (Watson et al., 2010). Here we present a mini-atlas of the common marmoset (*Callithrix jaccus*), which is one of representative experimental primates for modern neuroscience. We further discuss the differences of brain structures between rodents and primates.

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Contents

Abbreviations: 12N, hypoglossal nucleus; 2n, optic nerve; 3N, oculomotor nucleus; 3V, third ventricle; 4V, fourth ventricle; 4n, trochlear nerve; 5N, motor trigeminal nucleus; 6N, abducens nucleus; 7N, facial nucleus; ac, anterior commissure; Amb, ambiguus nucleus; cp, cerebral peduncle; CSF, cerebrospinal fluid; dcw, deep cerebral white matter; DLG, dorsal lateral geniculate nucleus; ec, external capsule; fi, fimbria of fornix; ic, internal capsule; icp, inferior cerebellar peduncle; LV, lateral ventricle; mcp, middle cerebellar peduncle; ml, medial lemniscus; och, optic chiasm; opt, optic tract; p1, prosomere 1; p2, prosomere 2; p3, prosomere 3; rcc, rostrum of corpus callosum; s5, sensory root of trigeminal nerve; scp, superior cerebellar peduncle; sp5, spinal trigeminal tract; ST, bed nucleus of stria terminalis; VMH, ventromedial hypothalamic nucleus; VPL, ventroposterior lateral nucleus; VPM, ventroposterior medial nucleus; VTA, ventral tegmental area.

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1. Introduction

Q2 Neuroscience research expands its boundaries each year. Many nuclei and fiber tracts are involved in various higher and complicated brain functions, which are the focus of a great deal of modern research. In such situation, students and young researchers need to be able to recognize many functionally related brain structures and know their spatial relationships.

The concept of a mini-atlas of the rat brain (Watson et al., 2010; Paxinos and Watson, 2014) was introduced to help those who are unfamiliar with mammalian neuroanatomy. In the mini-atlas, a small number of representative brain sections were selected to show the whole rat brain, in which a limited number of terms were indicated for important structures. Differences in shape of continuous nuclei between sections were clearly shown in the color-coded mini-atlas.

Due to growing use of the common marmoset (*Callithrix jaccus*) in recent neuroscience research, we have launched a website showing brain sections of the marmoset at http://marmoset-brain.org (Tokuno et al., 2009). About 1000 brain structures including nuclei and fiber tracts were identified in an atlas based on these sections (Paxinos et al., 2012). Although the use of many different technical terms is vital for neuroscience research, it is not usually realistic for students and young researchers to learn general organization of the marmoset brain with an atlas such as this.

Here we provide a mini-atlas of the common marmoset brain. It is a crucial feature of this mini-atlas that we selected brain sections of the marmoset that correspond to those in the rat mini-atlas. Furthermore, we used the same abbreviations and color code system for the marmoset mini-atlas as the rat mini-atlas for each corresponding brain structure. Understanding the marmoset and rat mini-atlases will make it easier for students to understand the basic organization in the mammalian brain including human brain.

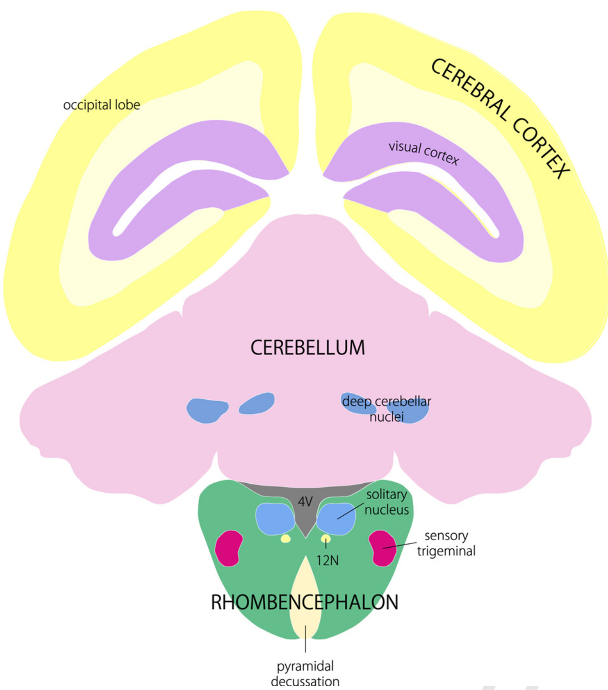

Fig. 1. Level P 4.0. The hindbrain at the level of the pyramidal decussation.
This section shows the caudal end of the hindbrain, just before it joins the spinal cord. The hindbrain consists of the rhombencephalon and a small segment called the isthmus which joins the rhombencephalon to the mesencephalon. The cerebellum is also part of the hindbrain, because it grows out of the rhombencephalon and the isthmus. The cerebellum lies between the rhombencephalon and the occipital pole of the cerebrum. In the center of the hindbrain is the prominent crossing of the pyramidal tract (pyramidal decussation). The fibers in the pyramidal tract arise in the cerebral cortex and at this level they cross the midline to reach the opposite side of the spinal cord. The large trigeminal nuclei, which receive touch, pain, and temperature sensations from the face, are found in the lateral part of the hindbrain. This part of the trigeminal sensory complex is called the spinal trigeminal nucleus because Q5 it extends into the cervical spinal cord. Most of the remainder of the green area in this section is occupied by the reticular nuclei, which extend the whole length of the hindbrain. The large solitary nucleus lies in the floor of the fourth ventricle (4V). It receives taste and other visceral sensations from the head and internal organs of the thorax and abdomen. Just below is the hypoglossal nucleus (12N) that sends motor fibers to the tongue. The ventricular system is represented here by the caudal end of the fourth ventricle. Cerebrospinal fluid (CSF) can escape from the ventricular system via small holes in the roof of the fourth ventricle to reach the subarachnoid space.
The cerebellum, which is very large in monkeys and other primates, lies dorsal to the fourth ventricle. In developmental terms, the cerebellum grows out from the roof of the hindbrain. It consists of an outer layer of cerebellar cortex and a core of white matter (fibers). The deep cerebellar nuclei are embedded in the white matter of the cerebellum.
The occipital pole of the cerebrum sits above the cerebellum. The primary visual cortex lies on the medial side of the occipital pole. (For interpretation of the references to color in text, the reader is referred to the web version of this article.)

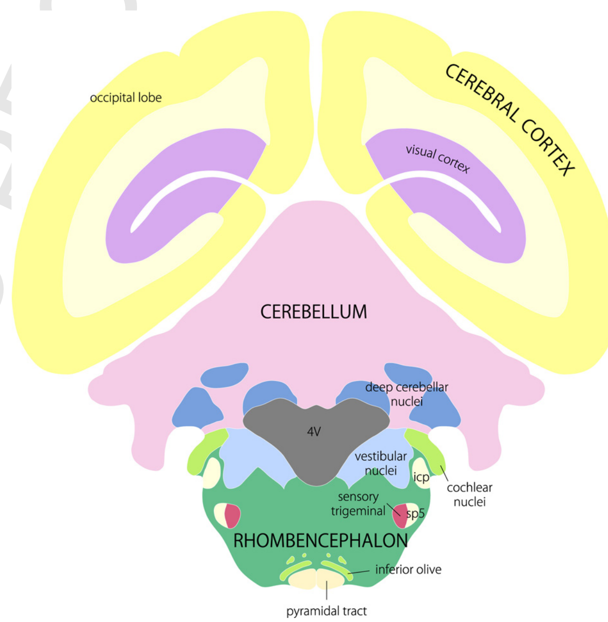

Fig. 2. Level P 2.5. The hindbrain at the level of the vestibular and cochlear nuclei.
This section shows the hindbrain (rhombencephalon) below and the cerebellum and cerebrum above. The large trigeminal nuclei are found in the lateral part of the hindbrain. The large vestibular nuclei lie in the floor of the fourth ventricle (4V) and the cochlear (auditory) nuclei are lateral to the vestibular nuclei. The inferior cerebellar peduncle (icp) lies between the vestibular and cochlear nuclei. It contains fibers that travel from the spinal cord and inferior olive to the cerebellum. Below the vestibular nuclei is the sensory trigeminal nucleus. This part of trigeminal sensory complex is called the spinal trigeminal nucleus and the trigeminal nerve fibers lateral to it are called the spinal trigeminal tract (sp5). A large fiber bundle, the pyramidal tract, lies on either side of the midline on the ventral margin of the hindbrain. The fibers in the pyramidal tracts arise in the cerebral cortex and travel down to cross to the opposite side of the spinal cord. Above each pyramidal tract is the inferior olive, which is functionally connected with the cerebellum of the opposite side. Most of the remainder of the green area of the hindbrain in this section is occupied by the reticular nuclei, which extend for the whole length of the hindbrain. The fourth ventricle contains cerebrospinal fluid (CSF), which has flowed down from its origin in the lateral (cerebral) ventricles through the third ventricle and aqueduct to reach the hindbrain.
The cerebellum is concerned with coordination of movement. It consists of an outer layer of cerebellar cortex and a core of white matter (fibers). The deep cerebellar nuclei are embedded in the white matter of the cerebellum. The deep cerebellar nuclei receive input from the cerebellar cortex and send fibers to the brainstem and thalamus.
The occipital pole of the cerebrum sits above the cerebellum. The primary visual cortex lies on the medial side of the occipital lobe. (For interpretation of the references to color in text, the reader is referred to the web version of this article.)

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