Hypothalamus

The hypothalamus is located below the thalamus, just above the brainstem. In the terminology of neuroanatomy, it forms the ventral part of the diencephalon. All vertebrate brains contain a hypothalamus. In humans, it is roughly the size of an almond.

They contain a number of small nuclei.

Regions

Anterior Hypothalamus

Tuberal Hypothalamus

Posterior Hypothalamus

Functions

One of the most important functions of the hypothalamus is to link the nervous system to the endocrine system via the pituitary gland.

The hypothalamus is responsible for certain metabolic processes and other activities of the autonomic nervous system. It synthesizes and secretes certain neurohormones, often called releasing hormones or hypothalamic hormones, and these in turn stimulate or inhibit the secretion of pituitary hormones. The hypothalamus controls body temperature, hunger, important aspects of parenting and attachment behaviors, thirst, fatigue, sleep, and circadian rhythms.

Structure

The hypothalamus is a brain structure made up of distinct nuclei as well as less anatomically distinct areas. It is found in all vertebrate nervous systems. In mammals, the axons of magnocellular neurosecretory cells in the paraventricular nucleus and the supraoptic nucleus (both located in the hypothalamus) contain oxytocin and vasopressin (antidiuretic hormone), and project into the posterior pituitary.

Much smaller parvocellular neurosecretory cells, neurons of the paraventricular nucleus, release corticotropin-releasing hormone and other hormones into the hypophyseal portal system, where these hormones diffuse to the anterior pituitary.

Connections

Neural connections

The hypothalamus is highly interconnected with other parts of the central nervous system, in particular the brainstem and its reticular formation. As part of the limbic system, it has connections to other limbic structures including the amygdala and septum, and is also connected with areas of the autonomous nervous system.

The hypothalamus receives many inputs from the brainstem, the most notable from the nucleus of the solitary tract, the locus coeruleus, and the ventrolateral medulla.

Most nerve fibres within the hypothalamus run in two ways (bidirectional).

Projections to areas caudal to the hypothalamus go through the medial forebrain bundle, the mammillotegmental tract and the dorsal longitudinal fasciculus.

Projections to areas rostral to the hypothalamus are carried by the mammillothalamic tract, the fornix and terminal stria.

Projections to areas of the sympathetic motor system (lateral horn spinal segments T1-L2/L3) are carried by the hypothalamospinal tract and they activate the sympathetic motor pathway.

Stimulation

In 2008, Hamani et al reported an unexpected effect of hypothalamic stimulation in a 50-year-old man undergoing treatment for refractory obesity. When stimulation was initiated intraoperatively at the most ventral contact, the patient reported experiencing a sudden sense of déjà vu, recalling a scene from 20 years earlier that became increasingly vivid as stimulation intensity increased. When electrode coordinates were plotted into stereotactic space, the ventral-most contacts were found to be in close association with the fornix [1)].

Hypothalamic disorder

Hypothalamic disorders involve dysfunction or abnormalities in the hypothalamus, a small but crucial part of the brain located just above the pituitary gland. The hypothalamus plays a central role in regulating various bodily functions, including temperature, hunger, thirst, sleep, emotional responses, and the release of hormones from the pituitary gland. Disorders affecting the hypothalamus can have widespread effects on the body.

Here are some common hypothalamic disorders:

Hypothalamic Dysfunction:

This can result from various causes, such as tumors, trauma, infections, or vascular issues affecting the hypothalamus. Dysfunction may disrupt the normal regulation of hormones and bodily functions.

Hypothalamic-Pituitary Axis Disorders:

The hypothalamus is closely linked to the pituitary gland, and disruptions in this connection can lead to hormonal imbalances. Conditions like hypopituitarism or hyperpituitarism can impact hormone production.

Hypothalamic Obesity:

Damage to the hypothalamus, often due to tumors or injury, may lead to obesity. This type of obesity can be challenging to manage through standard weight loss methods.

Central Diabetes Insipidus:

This condition results from a deficiency in antidiuretic hormone (ADH) production or its action. It leads to excessive thirst and urine production.

Hypothalamic Hamartoma:

This is a rare tumor in the hypothalamus, often present from birth. It can cause various symptoms, including seizures and hormone imbalances.

Hypothalamic Amenorrhea:

In women, disruptions in the hypothalamus can lead to a cessation of menstrual cycles due to changes in the release of gonadotropin-releasing hormone (GnRH).

Neuroendocrine Disorders:

The hypothalamus is a key regulator of the neuroendocrine system. Disorders in this system can affect hormone release and lead to various symptoms.

Diagnosis and treatment of hypothalamic disorders often involve a multidisciplinary approach, including neurology, endocrinology, and sometimes neurosurgery. Treatment depends on the specific disorder and may involve managing symptoms, addressing underlying causes, or hormone replacement therapy. If you suspect a hypothalamic disorder, it's essential to consult with a healthcare professional for a thorough evaluation and appropriate management.

1)
Hamani C, McAndrews MP, Cohn M, et al.. Memory enhancement induced by hypothalamic/fornix deep brain stimulation. Ann Neurol. 2008;63(1):119–123.