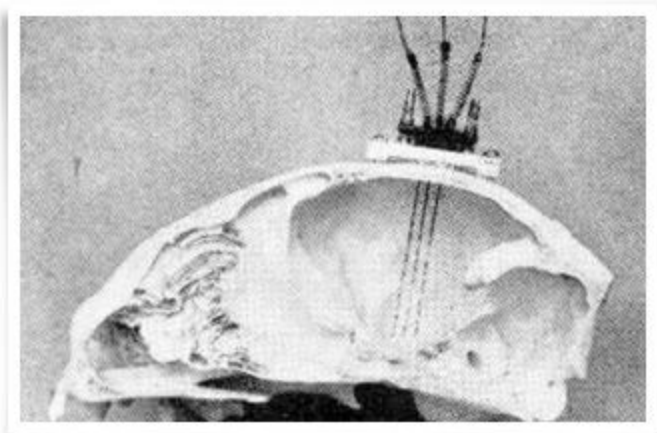




## Walter Hess: Swiss Physiologist, 1881-1973

Walter R. Hess was a noted Swiss neurophysiologist whose work led to a broader understanding of the autonomic nervous system than that presented by Langley. Langley had demonstrated that the autonomic nervous system operated independently of the central nervous system by isolating the organs from central nervous system influence. Hess built upon Langley's framework by exploring the extent to which the brain centers influenced the autonomic nervous system. Hess hypothesized that the autonomic nervous system was not fully disconnected from the central nervous system and the brain. Instead, he saw the autonomic nervous system as part of a broader, integrated system.

To test his hypothesis, Hess developed sophisticated probes (for the day), which allowed him to insert fine electrodes into the brains of cats. By stimulating various groups of cells with a slight electrical current, Hess found he could control movement, emotional state, and autonomic reactions (e.g., sweating, pupil dilation, etc). With a flip of a switch, Hess was able to instantly transform a cat's demeanor from friendly and purring to hissing and clawing, and he could do this reliably. In the 1920s, he focused specifically on the influence of the hypothalamus on the autonomic nervous system. He found that stimulation of the hind region of the thalamus tended to prepare the cat for action, whereas stimulation the frontal region tended to cause relaxation. In this way, Hess had discovered another control center for the sympathetic and parasympathetic systems and proved conclusively that bodily functions are related to the posterior and middle regions of the hypothalamus.



W.R. Hess, Electrodes with mounts and holders in place. Skull halved. Non-insulated needle-tips reach the hypothalamic area, as depicted in his 1954 book, *Diencephalon: Autonomic and Extrapramidal Functions* and *Extrapramidal Functions*.

Hess's detailed, methodical mapping of the influence of the hypothalamus would encourage later scientists to expand his investigations and create very complete brain maps. Hess's discoveries and detailed brain mapping were highly significant and earned him the Nobel Prize in 1949. In his Nobel lecture, Hess stated: "One thing had nevertheless become clear, namely that the parts of the brain communicating directly with the spinal cord at the upper end – the medulla oblongata, and the segment lying directly beneath the cerebrum, the so-called diencephalon – exert a decisive influence on the vegetative controlling mechanisms. As regards the diencephalon, further orientation had been achieved to the extent that it was realized that the parts of it lying nearest the base of the skull, i.e., the hypothalamus, were particularly important to the nature of the whole enquiry."

While Hess unequivocally demonstrated that the autonomic nervous system was fully integrated with the central nervous system, many not directly involved in research involving the autonomic nervous system continue to reference the human nervous human nervous system structure put forth by Langley. **The figure below outlines the human nervous system structure as redefined by Hess:**

# HUMAN NERVOUS SYSTEM

CENTRAL NERVOUS SYSTEM

PERIPHERAL NERVOUS SYSTEM

## BRAIN & SPINAL CORD

1) Mediates & directs body's external activity using inter-neural pathways to take in & send out information.

<i>Receives</i>	<i>Determines</i>	<i>Sends</i>
external sensory input notification	necessary external action/inaction	directive to engage external action/inaction
↑ ↑ ↑		↓ ↓ ↓

↑ <b>SOMATIC NERVOUS SYSTEM</b>	↓
Works with CNS to manage body's external response system.	↓
<i>Takes in</i> external sensory input	
↳ <i>Relays</i> message to CNS	↓
<i>Engages</i> external motor response	↳

2) Influences body's internal activity using inter-neural pathways.

<i>Can Influence</i>	<i>Receives Updates</i>
internal motor response	regarding internal body function
↓ ↓ ↓	↑ ↑ ↑

↳ **AUTONOMIC NERVOUS SYSTEM** ↓

Manages, mediates, engages body's internal response system. , *communicates with and can be influenced by CNS system*. Maintains homeostasis in the body.

*Takes in* internal sensory input

*Determines* internal action/inaction *be influenced by CNS*

*Engages* internal motor response in organ, gland, or smooth muscle

<b>SYMPATHETIC SYSTEM</b>	<b>PARASYMPATHETIC SYSTEM</b>	<b>ENTERIC SYSTEM</b>
Alarm State Fight & Flight	Normative State Rest & Digest	