

STATE OF THE BODY

Anatomy and Function: Autonomic Nervous System (ANS)

The ANS is made up of the **Sympathetic**, **Parasympathetic**, and **Enteric** Nervous systems. The Parasympathetic and Sympathetic are the most common ones:

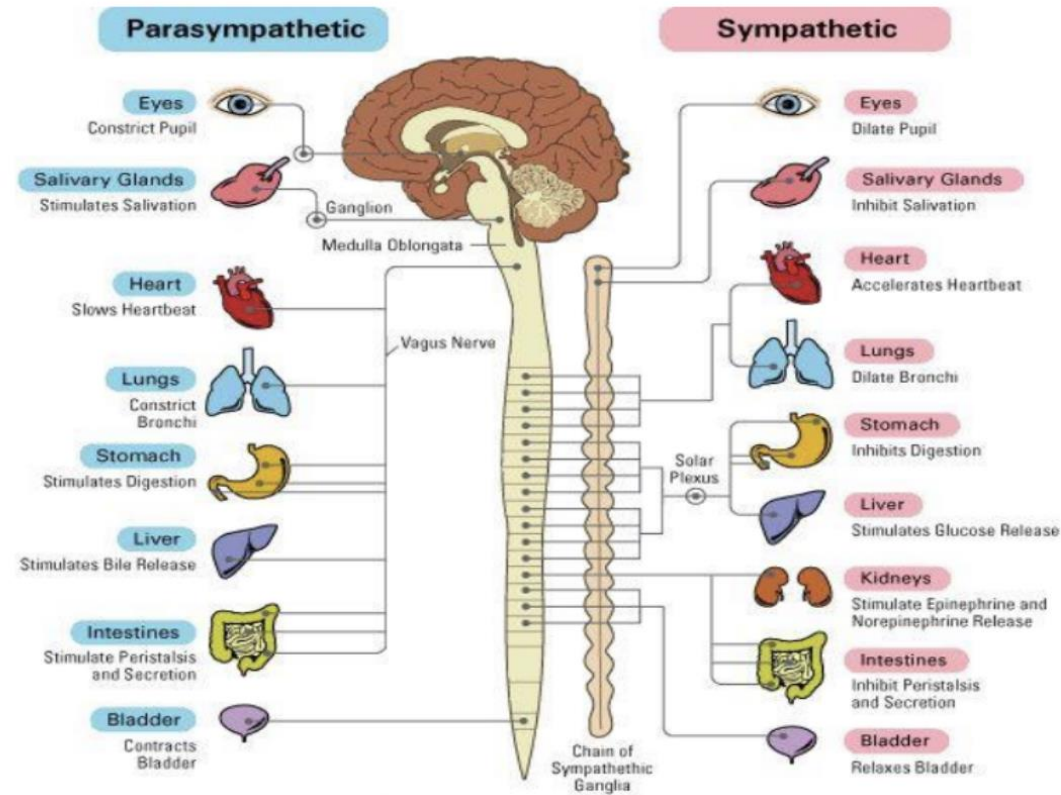


Figure 1: Parasympathetic fibers emerging from sacral (sacrum-related) and cranial region. Sympathetic fibers emerging from upper lumbar and thoracic regions of the spinal cord.

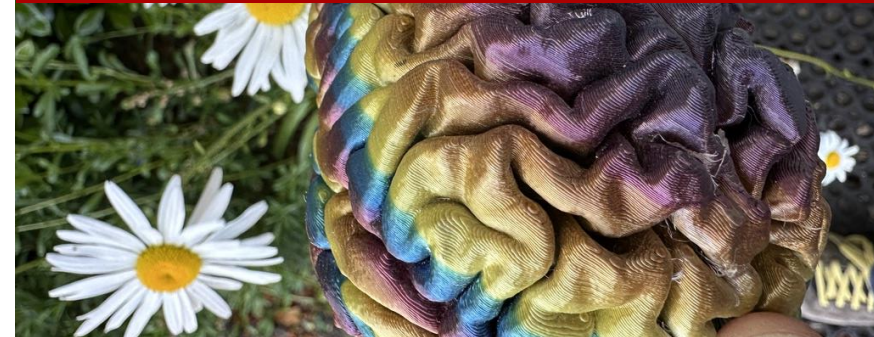
Source: Autonomic Nervous System: A Comprehensive Review (2023)

There are three primary ANS divisions:

SYMPATHETIC (Four F's: associated with fight or flight, and the increased availability of energy resources)

PARASYMPATHETIC (SLUD; associated with a more relaxed state, and energy conservation)

ENTERIC (Second brain: associated with digestion and activity/microbiome of the gastrointestinal tract)

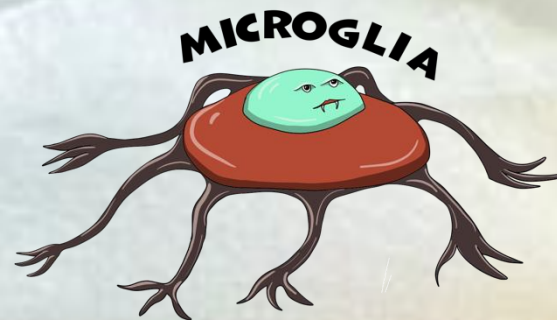


REACTIVITY VS. REGULATION



Emotional reactivity: autonomic response to stimuli. Some of us have BIG sympathetic responses, and some of us respond less. We pretty much arrive with a certain level of reactivity. Do you experience big sympathetic responses, or small? What if a spider dropped on your lap? What if you held a human brain specimen?

Emotional regulation: parasympathetic modulation of our bodily responses. Frontal lobe networks get trained through social experience to help inhibit, modulate – and regulate – our emotional responses, and thus our behavior.



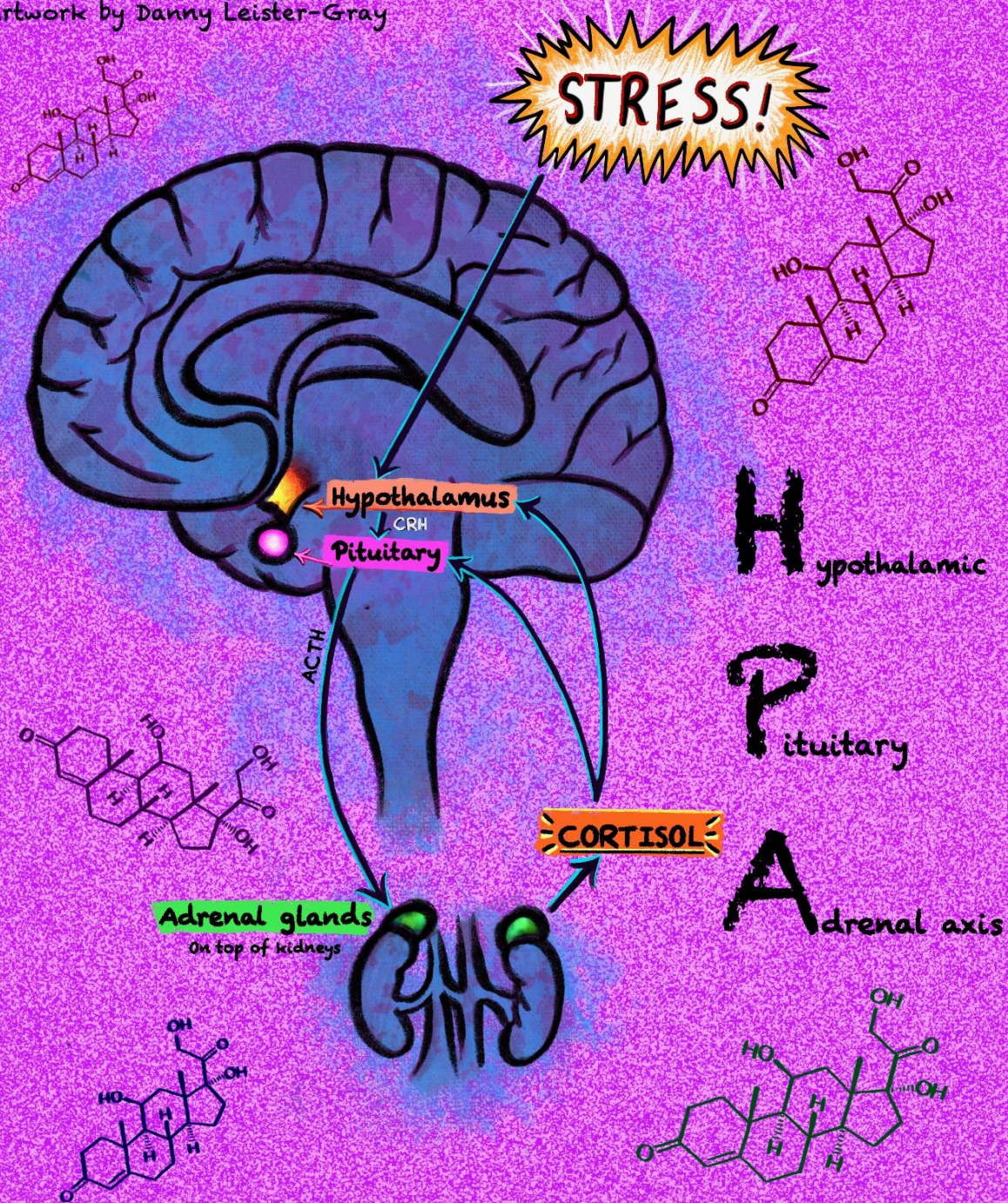
"Spider" (1996), Louise Bourgeois
New Orleans Museum of Art

STRESS RESPONSE

"A zebra's stress response kicks in when a zebra is chased by a lion; when the zebra escapes, the stress response shuts off. In between predation attempts, the zebra is at ease. It doesn't flood itself with stress hormones wondering when the next lion is going to show up...Primates are super smart and organized just enough to devote their free time to being miserable to each other and stressing each other out. But if you get chronically, psychosocially stressed, you're going to compromise your health...we've evolved to be smart enough to make ourselves sick." -Robert Sapolsky



Artwork by Danny Leister-Gray



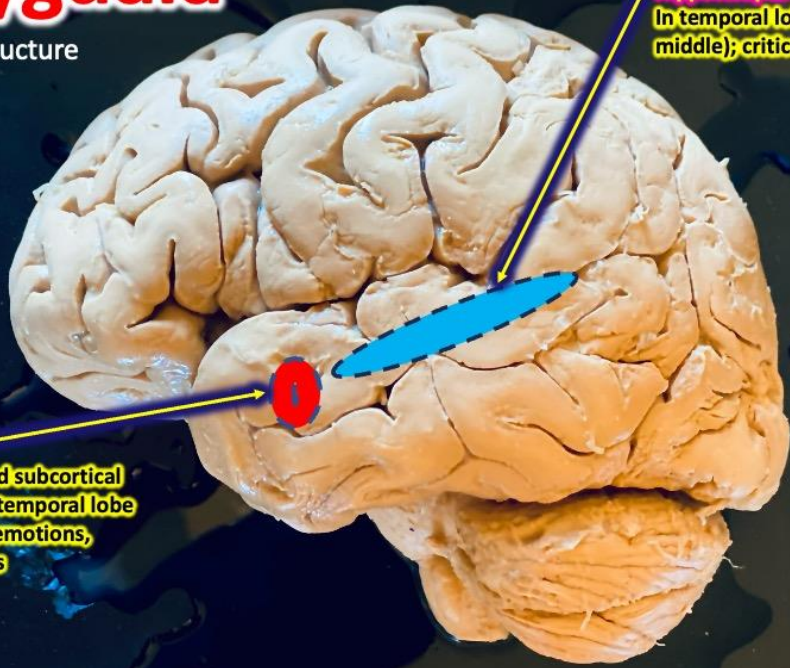
LIMBIC SYSTEM

Amygdala

Limbic structure

Hippocampus
In temporal lobe (towards the middle); critical region for memory

Amygdala
Almond-shaped subcortical nucleus in the temporal lobe
Important for emotions, social decisions



The amygdala links detection of salient stimuli to increased sympathetic and HPA axis activity, can cause you to freeze, and can drive impulsive, reflexive behavior over considered responses.

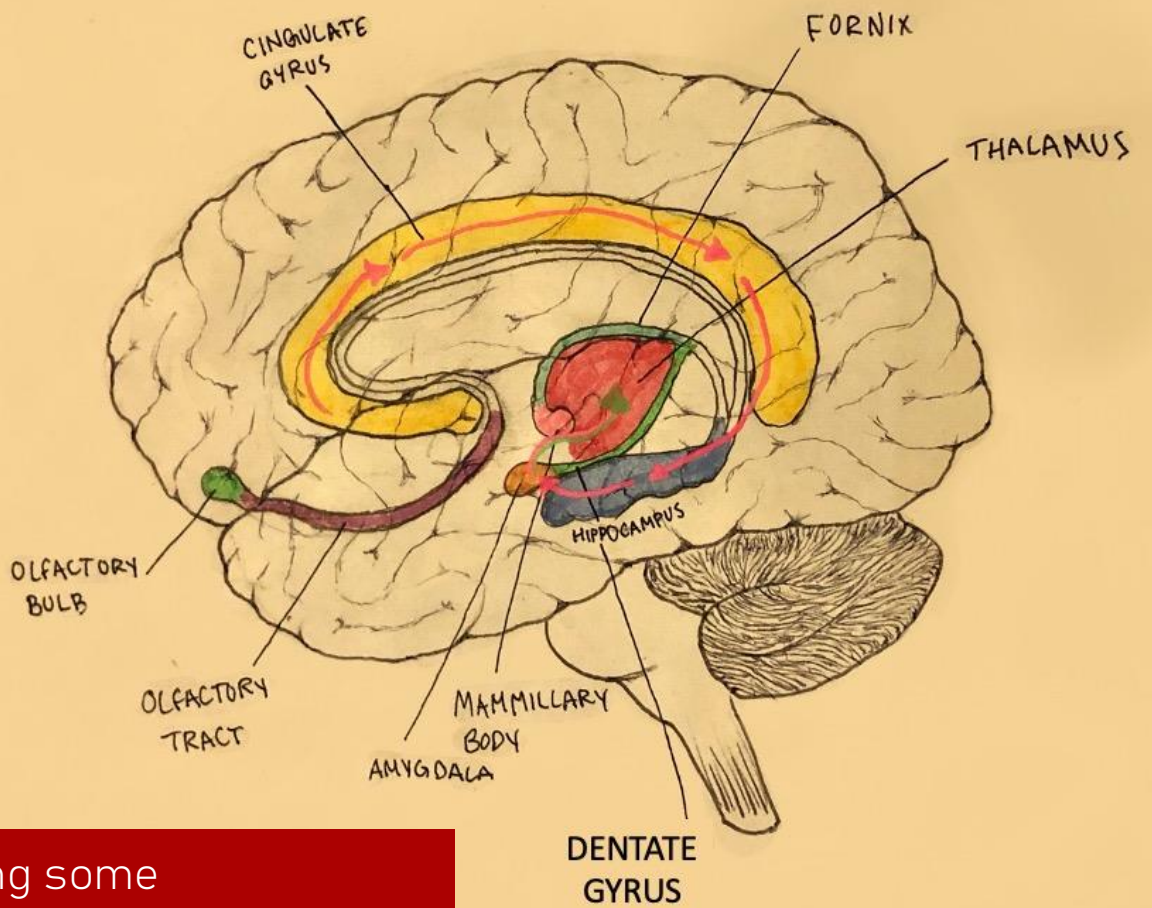
GO PLACES
EXAMINE BRAINS
ASK QUESTIONS
MAKE ART



LAB #8: LIMBIC SYSTEM

LIMBIC SYSTEM

by Josie Borden



The limbic system refers to those areas of the brain, including some evolutionarily ancient cortical (paleocortical) regions and some subcortical structures, that are involved in emotional experience and expression.

BODY...AND BRAIN

Autonomic balance, HPA axis, limbic system – and frontal lobe/insular networks!

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Human Brain
 Mid-sagittal view

Thalamus
 Important initial processing of sensory information
 All afferent inputs except olfaction (smell) synapse here

Corpus Callosum
 Large band of myelinated cortical axons
 Connects left and right hemisphere

Anterior Cingulate Gyrus
 Critical medial frontal lobe region that links perception of body state to behavior

Frontal lobe
 Social decision making
 Motor planning and output
 Under development through adolescence/young adulthood

Amygdala
 Almond-shaped subcortical nucleus in the temporal lobe
 Important for emotions, social decisions

Parietal lobe
 Touch, pressure, vibration, position
 Integration of somatosensation, vision, vestibular
 Spatial mapping of body and surroundings

Occipital lobe
 Visual processing

Hippocampus
 In temporal lobe (hidden behind brainstem); critical region for memory

Cerebellum
 Balance, movement
 Various aspects of cognition
 Most neurons (69 billion!)

Brainstem
 Autonomic regulation (Vagus Nerve parasympathetic output), basic reflexes

The Insular Lobe

Frontal Lobe
Parietal Lobe
Anterior Insula
Posterior Insula
Temporal Lobe
Occipital Lobe
Cerebellum

INSULA
 (Latin for 'island')
 Deep within lateral (or Sylvian) fissure

The insular lobe cortex receives detailed somatosensory input from the viscera, along with 'nociceptive' (damaged tissue), itch, temperature & other emotionally salient details about your body state.

"Whether you see the person you are in love with, try to listen to your own heartbeat, suffer from a headache, or crave for a chocolate cookie, one part of your brain is sure to increase its activity strongly: the insular cortex..."
 Nadine Gogolla, The insular cortex, Current Biology (2017)

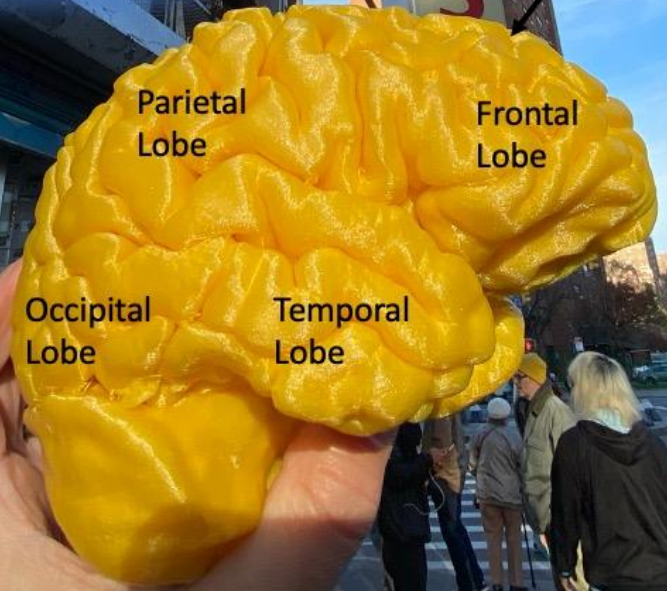
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Phineas Gage

A railroad construction foreman who survived a grisly 19th century accident – an iron tamping rod blew straight through his frontal lobes!

His personality changed, at least initially. He was impulsive, failing to inhibit inappropriate social behaviors, and had trouble organizing activities. Some accounts suggest that his social abilities did improve over time.

Katz's
Delicatessen,
NYC



Iron rod

Medial PFC
(pre-frontal cortex)

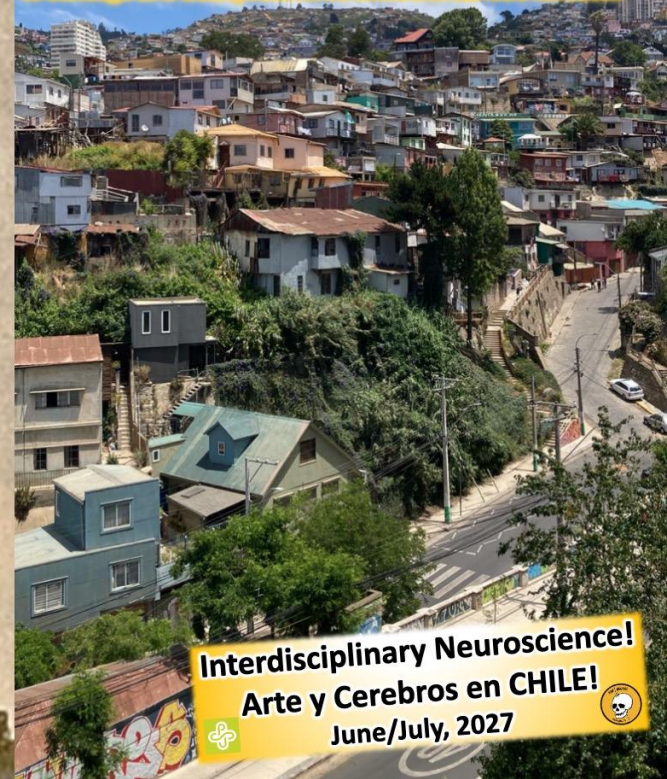


DID YOU KNOW that Phineas Gage lived in Valparaíso, Chile, after his infamous accident?! He drove a stagecoach from Valpo to Santiago and clearly recovered some frontal lobe function.



The bar that shot through the skull!

The skull



Interdisciplinary Neuroscience!
Arte y Cerebros en CHILE!
June/July, 2027

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"Gage was no longer Gage."

EXPERIENCE MATTERS

A young woman with dark hair, wearing a grey hoodie, has a wide-eyed, open-mouthed expression of shock or surprise. She is looking intently at a magnifying glass held over a petri dish. The petri dish contains a clear liquid and several small, light-colored, irregularly shaped objects. The background is blurred, suggesting an indoor setting like a classroom or laboratory.

Big sympathetic/amygdala reactions are a source of ENERGY. When we learn to channel that energy, there are huge benefits for motivation, engagement, stamina, resilience. People may crave more intense experiences. But if we get overwhelmed, it can lead to anxiety, chronic stress, panic...

How might educational experiences support *positive* reactions to strong emotional reactivity?