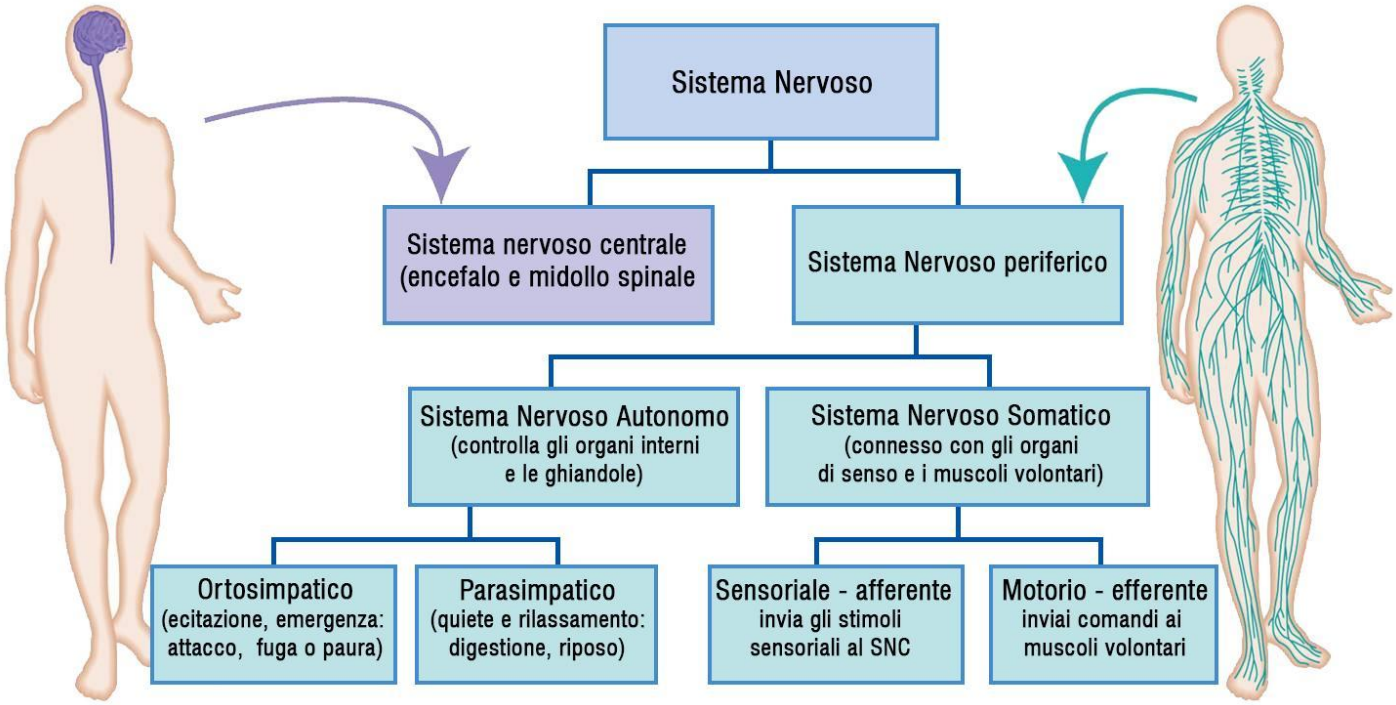
WHAT HAPPENS INSIDE THE BODY AND THE BRAIN

NEURO-PSYCO-PHYSIOLOGY OF EMOTIONS

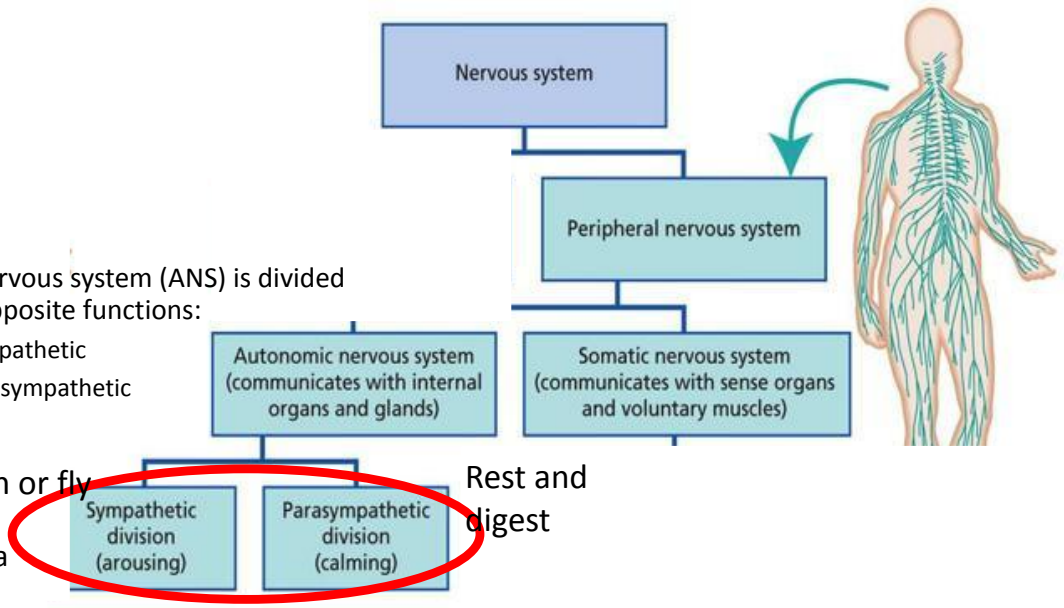
The nervous system



The nervous system - Peripheral

Autonomic nervous system (ANS) is divided into 2, with opposite functions:

- Sympathetic
- Parasympathetic



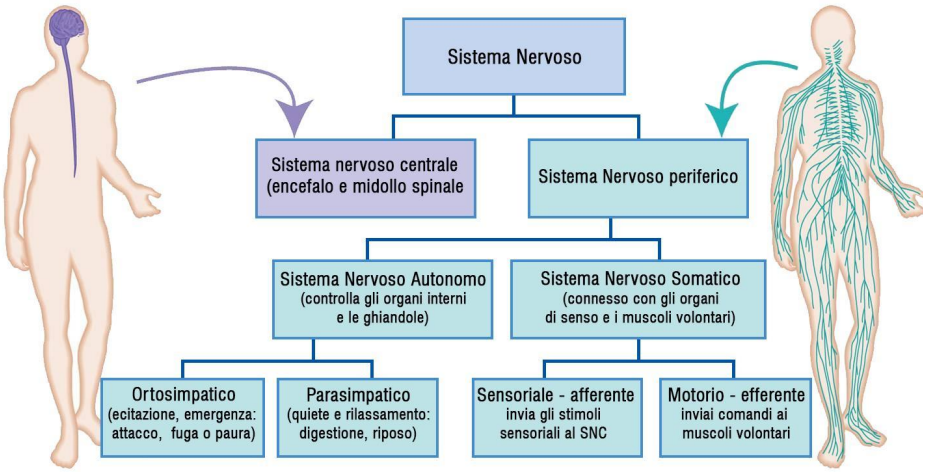
Figh or fly

Rest and digest

Respond «as a whole»

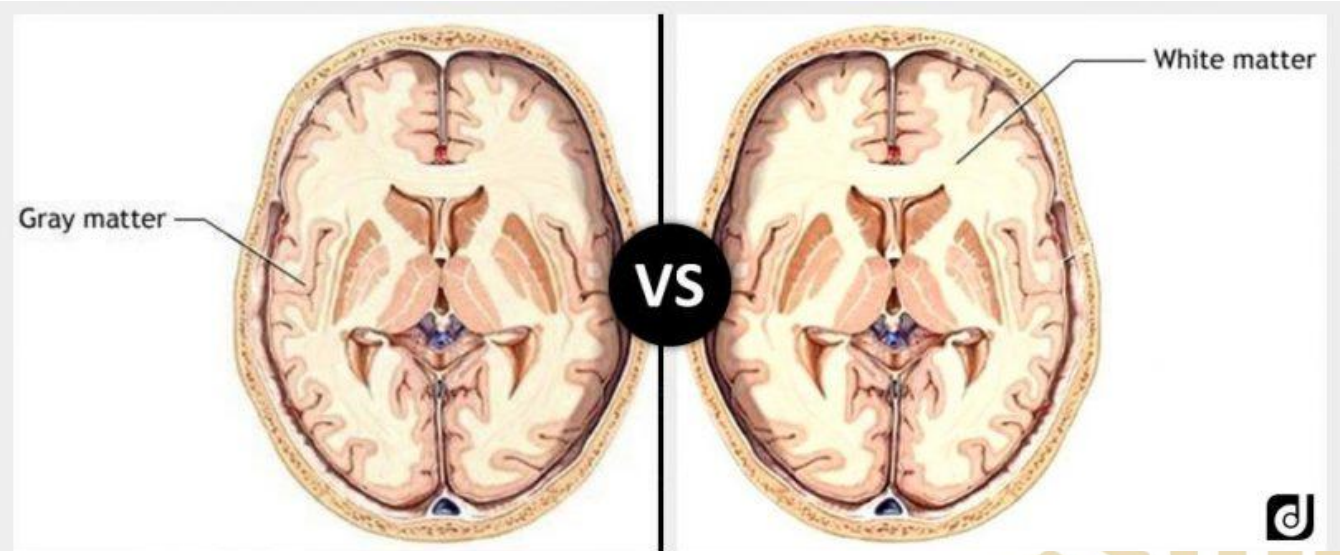
The nervous system - Central

- The **brain** receives feedback from the body in different ways:
  - From the Somatic Nervous System
    - senses
  - From the Autonomic Nervous System
    - viscera (visceral afferent system)
    - hormones produced by the endocrine system (also mediated by organs)



Brain structure: white and grey matter

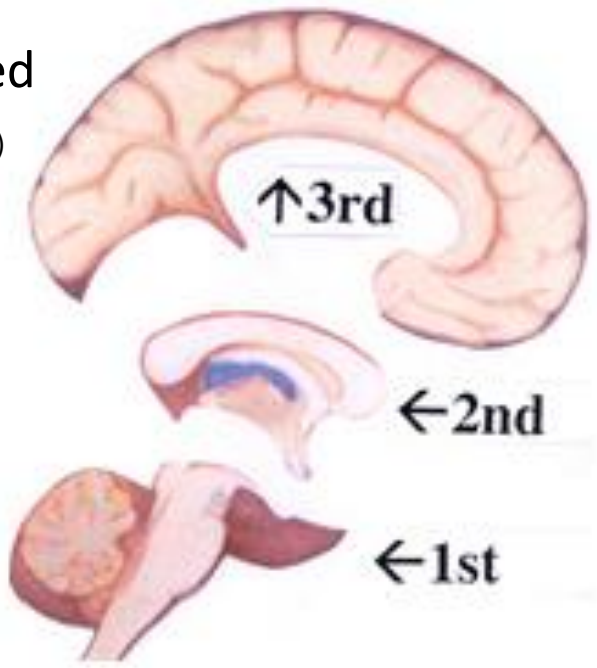
Grey matter: neurons
White matter: nerves and “cables”



https://www.koshland-science-museum.org/explore-the-science/interactives/brain-anatomy

Brain structure: the triune brain

Representation of the human brain as composed of 3 functional layers (strati) (Mac Lean, 50’s) □ ***triune brain***



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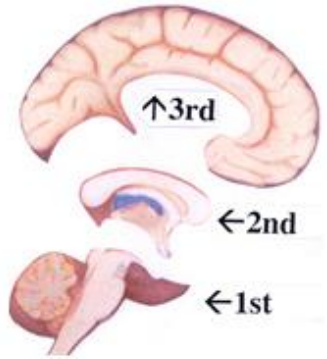
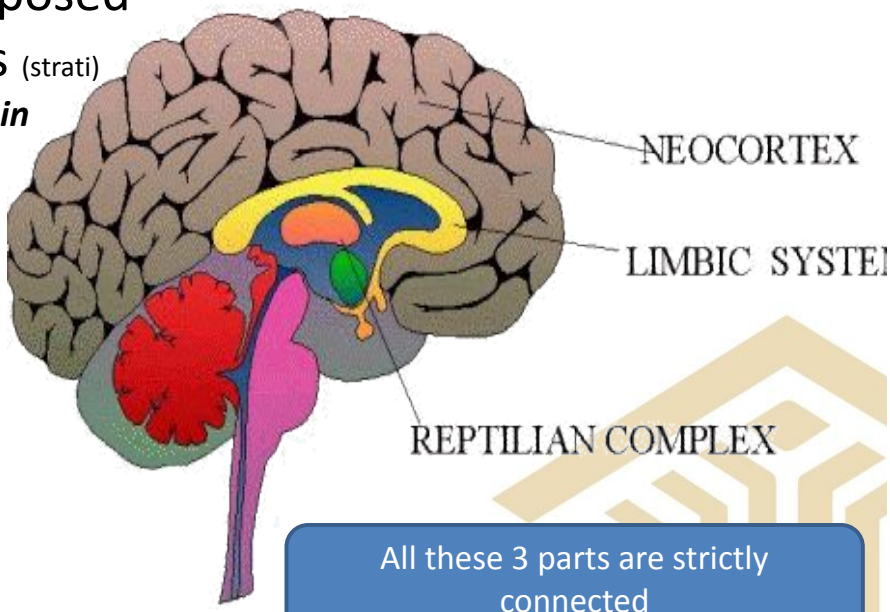
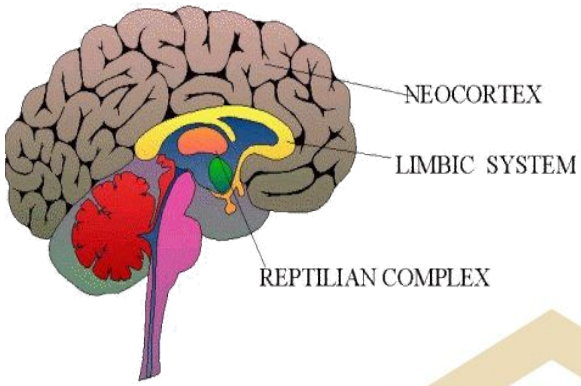




All these 3 parts are strictly connected
(see Damasios's book "Descartes' error)

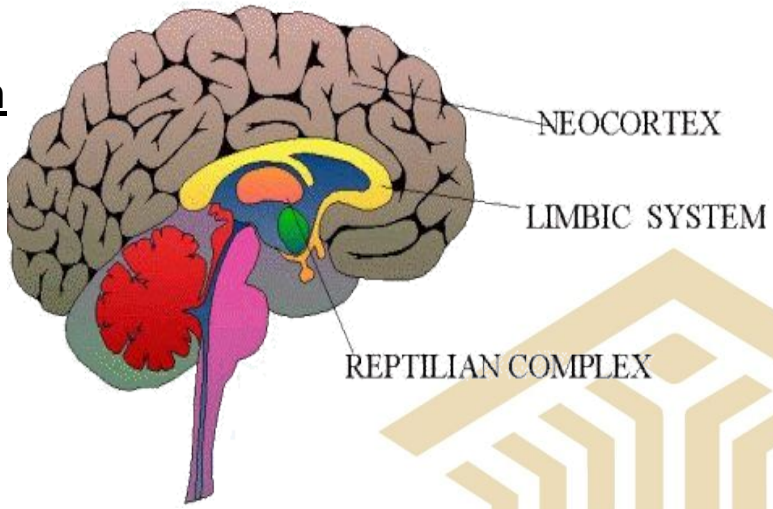
Brain structure: the triune brain

- **1. Reptilian**: the deepest (+ profonda) and oldest part of the brain; very similar in <u>all vertebrates</u>; has to do with automatic regulatory systems (temperature, heartbeat, etc.); includes hypothalamus and hypophysis.



Brain structure: the triune brain

- **2. Limbic system**: specific for the mammals (mammiferi) (not in fishes, reptiles, birds). Has to do with integration and regulation of **emotional** and **motivational** states



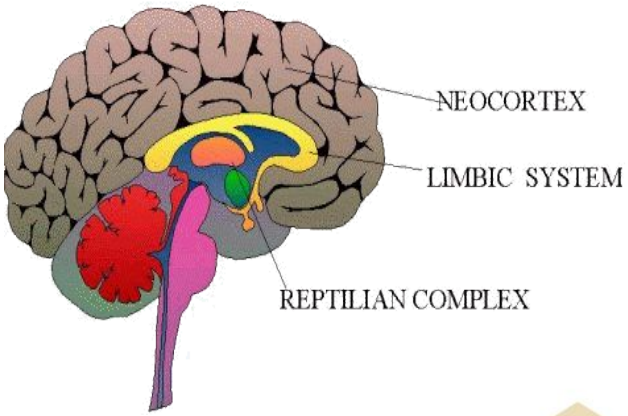
Limbic system (and especially the hypothalamus)

The place responsible for the 4 Fs

- fight (defend territory and properties)
- flight (avoid danger)
- feed (find food)
- … reproduction

Brain structure

- **3. Cortex**: is "the Ferrari of the brain", a shining machine; extremely developed in vertebrates and mammals, even more in primates and humans. It is not pure rationality (as it was once conceived), but it interacts with the more emotional part of the brain due to its strong connections with the limbic system



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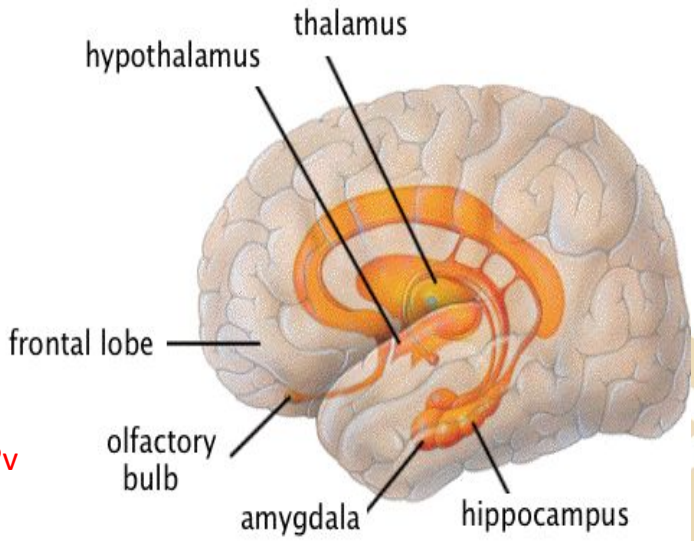
The limbic system

- Where is the limbic system located?
- What are the structures that compose it?

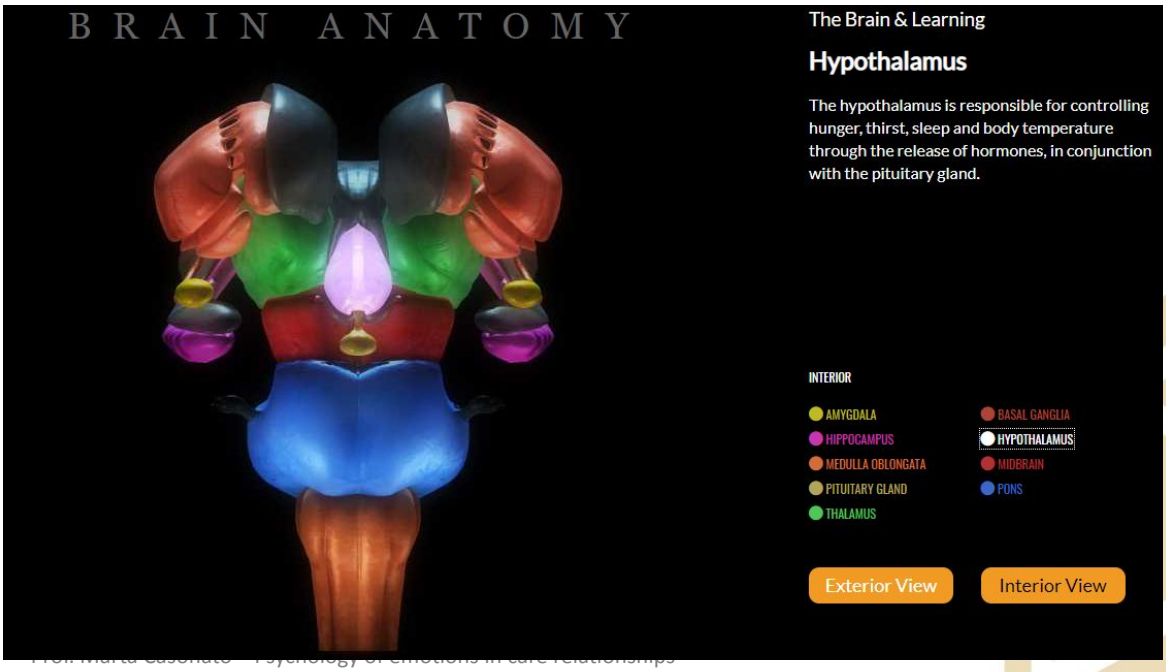


- https://www.youtube.com/watch?v=pcZVNb_5JgI

The limbic system

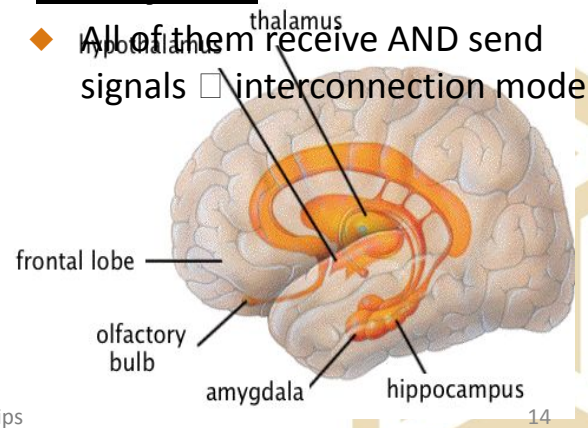
Alert!

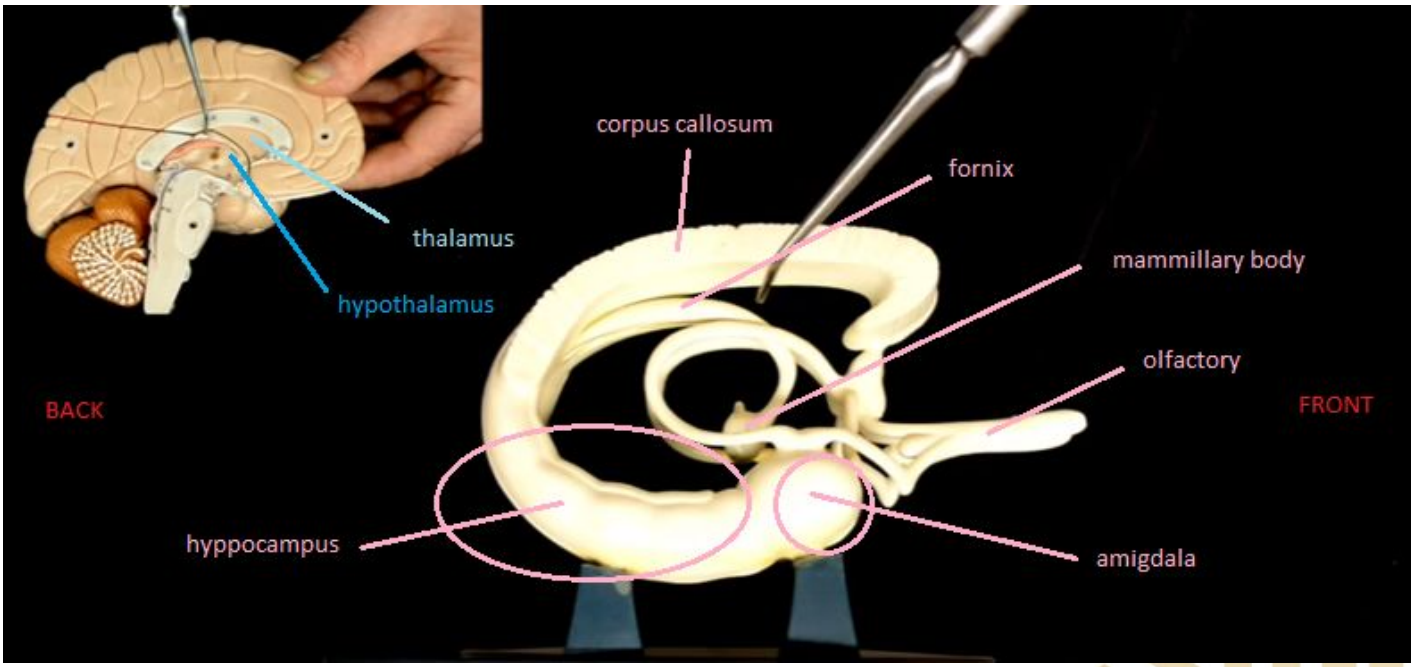
- **All the structures that we will present are bilateral and symmetrical!**
  - **Except for the cerebellum (cervelletto) and the hypothalamus (not double, but symmetrical)**



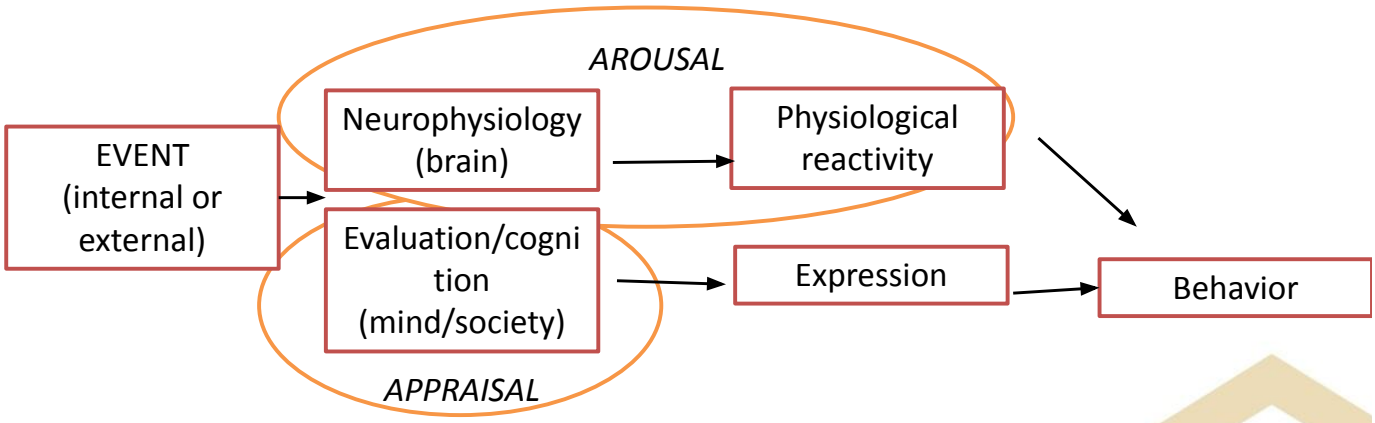
The limbic system

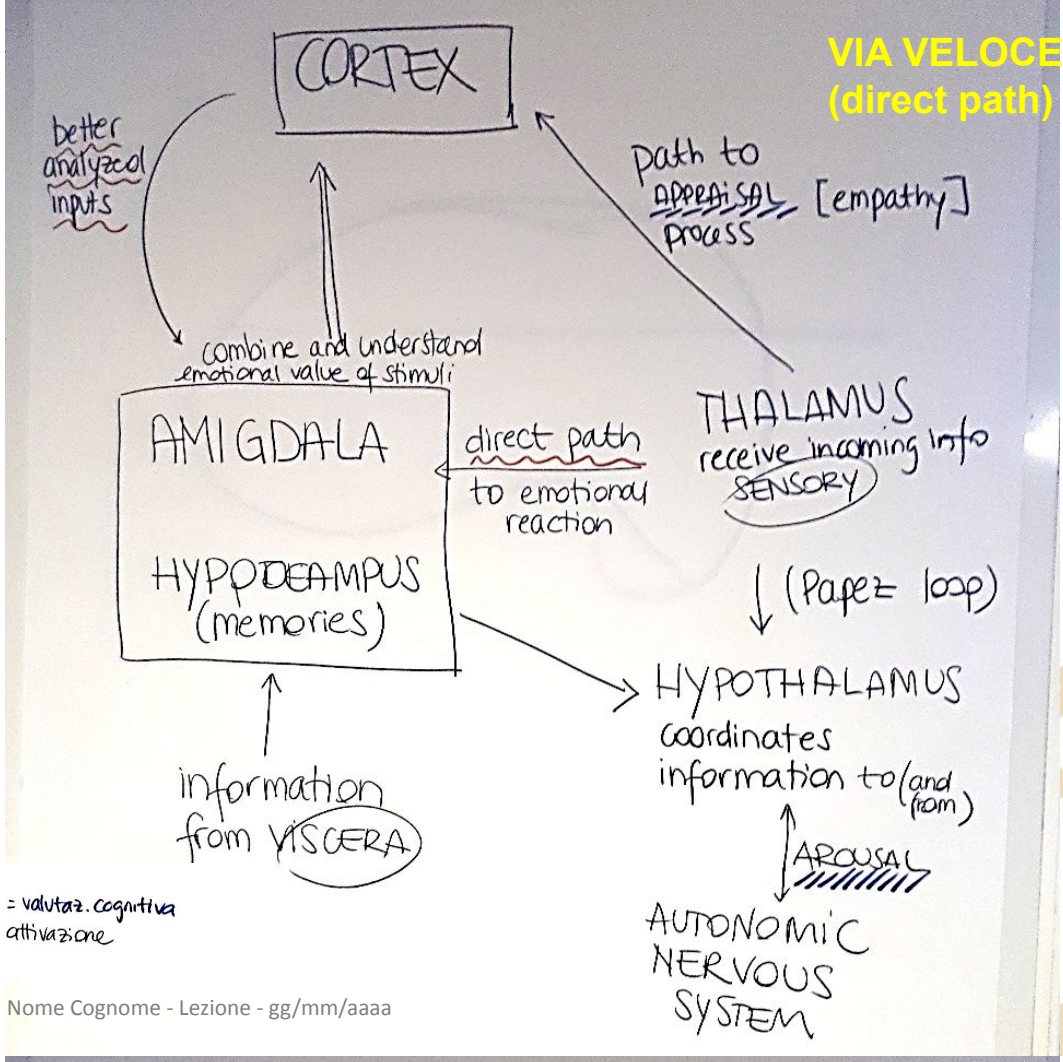
- Ethimology: from Latin *limbus* (lembo, marginale)
- "History" of the limbic system
  - Before known as the Papez loop (circuito di Papez)
  - **Nowadays we also include the pre-frontal cortex to this system** (Cortical and subcortical components)
- Responsible for:
  - Emotions
  - Memory
  - Behavior
  - Motivation
  - Olfaction
- Placed **atop and around the thalamus(es)**
- The limbic system is composed of **different structures working together as a system**
  - All of them receive AND send signals interconnection model

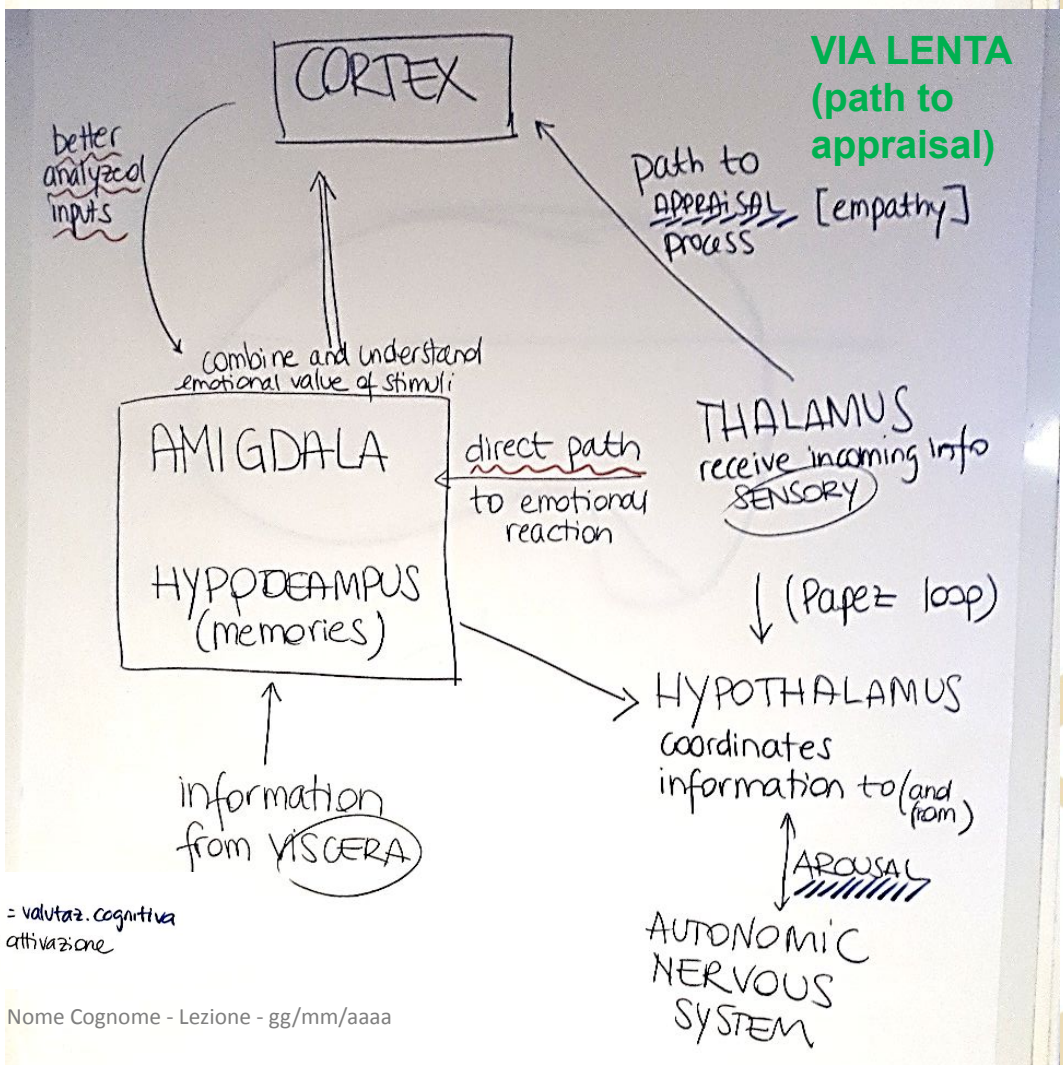




The process of emotions




VIA VELOCE
(direct path)
CORTEX
better analyzed inputs
path to APPRAISAL process
[empathy]
combine and understand emotional value of stimuli
AMIGDALA
HYPPOCAMPUS
(memories)
direct path to emotional reaction
THALAMUS
receive incoming info
SENSORY
(Papez loop)
HYPOTHALAMUS
coordinates information to (and from)
AROUSAL
AUTONOMIC NERVOUS SYSTEM
information from VISCERA
APPRAISAL = valutaz. cognitiva
AROUSAL = attivazione


VIA LENTA
(path to appraisal)
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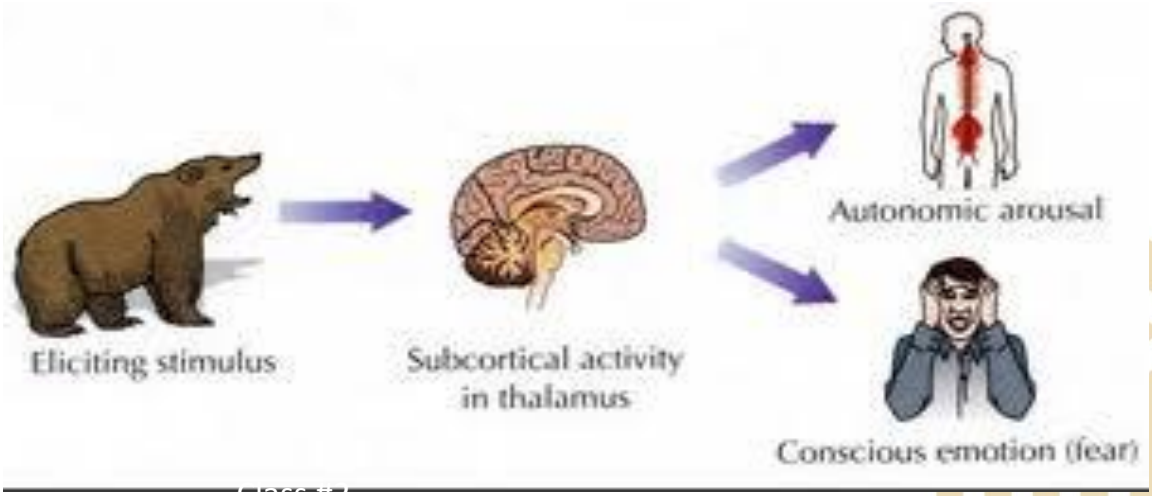
Physiology of emotions

- After Cannon, many other scientists worked in order to specify subcortical areas and functions



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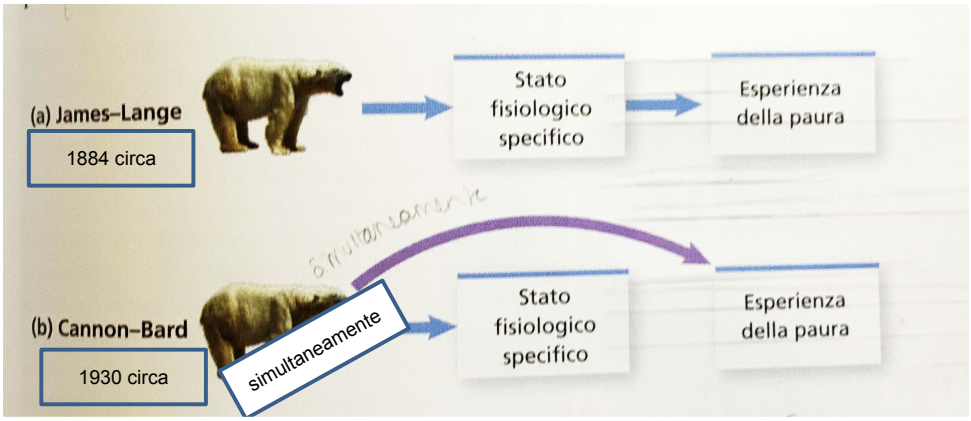


Dualities of emotions

- Functions
  - Informational
  - hedonic
- Processing:
  - Low-road (automatic and holistic)
  - high-road (more cognitively derived/culturally influenced)

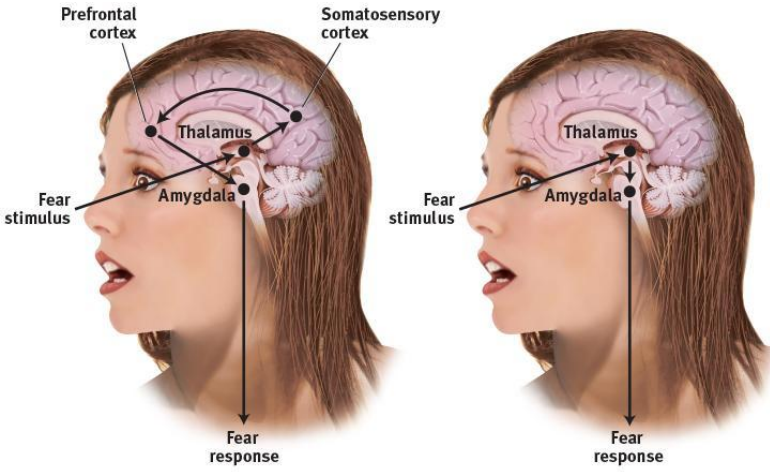
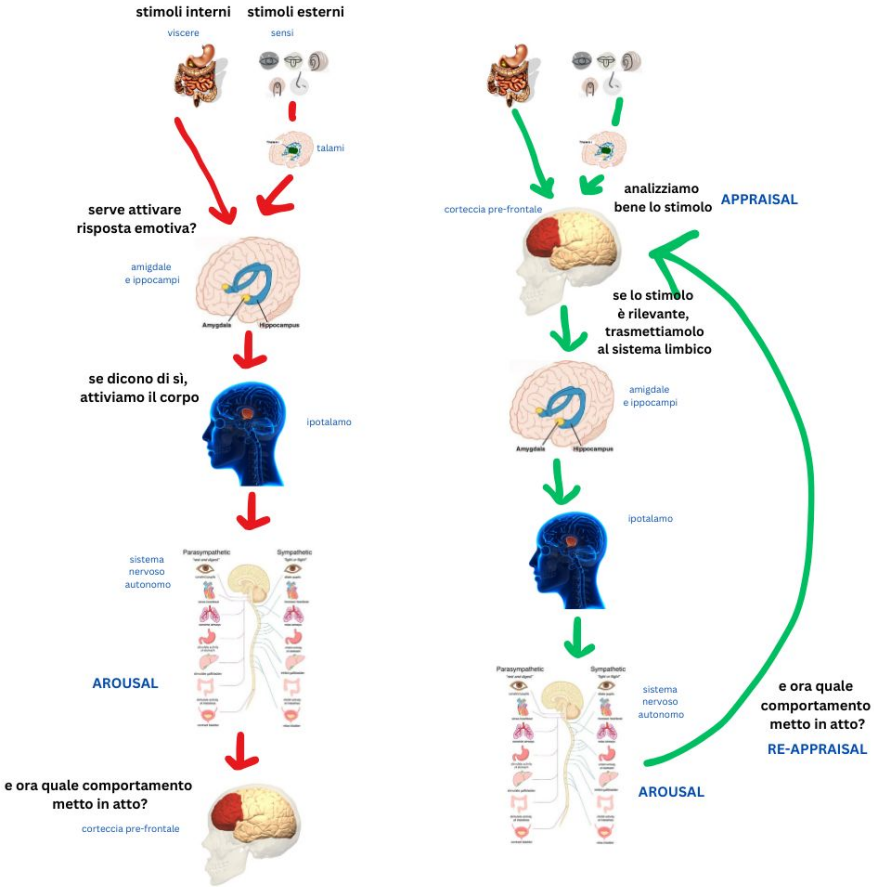
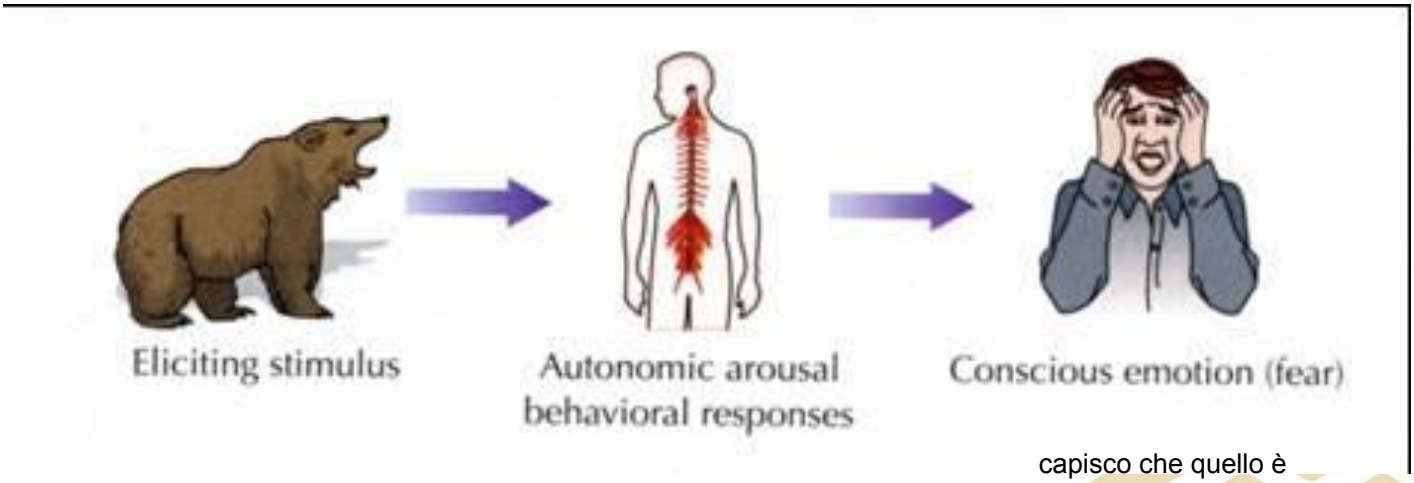


Figure 9.10
Myers/DeWall, *Psychology in Everyday Life*, 4e, © 2017 Worth Publishers



Example 1 - low road, via veloce



Vedo un orso

provo subito paura (via veloce), prima ancora di realizzare bene la situazione

capisco che quello è proprio un orso e quella che provo si chiama paura (via lenta) (appraisal)

Possiamo avere paura di qualcosa prima di sapere di cosa si tratta!

Example 2 - high road, via lenta

Vedo un orso

analizzo la situazione, realizzo che di fronte a me ho un orso e che questo può essere molto pericoloso

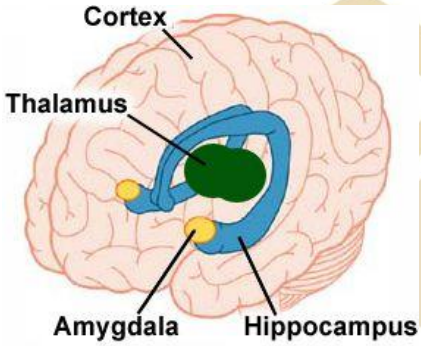
siccome sono in pericolo, provo paura

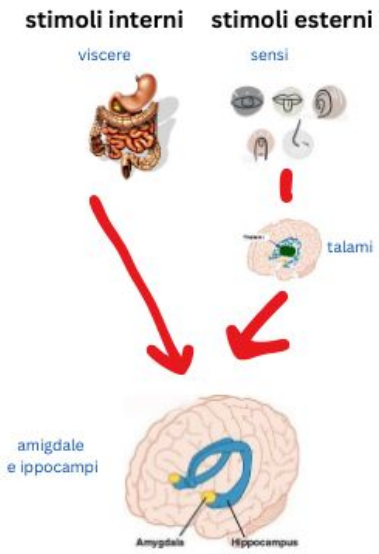
Possiamo avere paura di qualcosa prima di sapere di cosa si tratta!

The limbic system's structures - I

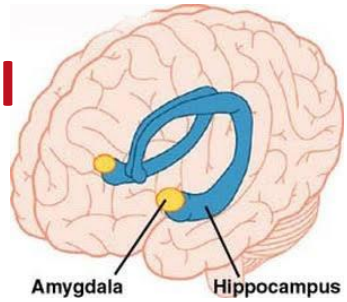
The thalamus(es)

- **IN**: Central station of **sensory information** (except smell) coming to the brain
- **OUT**:
  - To the **cortex** (if the thalamus does not work very well, the cortex cannot function at its best), that in turn send info to the amygdala (via lenta)
  - Directly to the **amygdala** (via veloce)





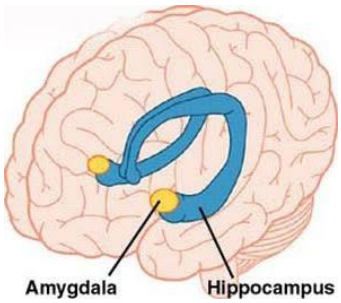
The limbic system's structures - II



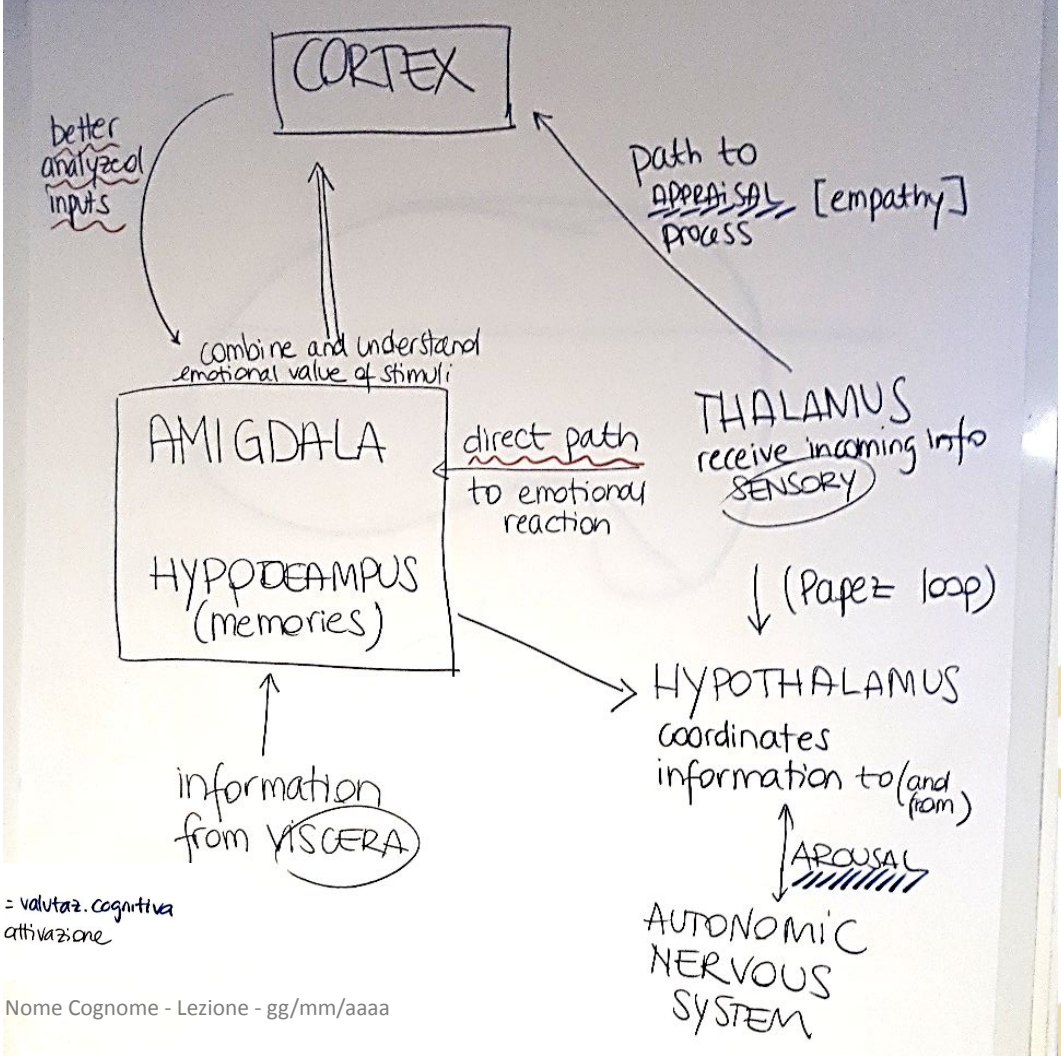
- **amygdalae (I)**
  - Latin word for almond (mandorla)
  - Placed behind the ears (under the cortex)
  - Cluster of neurons, high cellular density (grey matter: neurons)
  - Essential for emotions!

https://www.brainfacts.org/3d-brain#intro=true&focus=Brain-limbic_system-amygdala

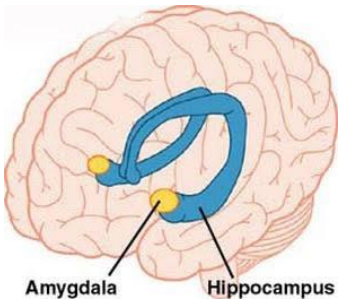
The limbic system's structures - II



- **amygdalae (II)**
  - Its known as «the ***emotional computer***»- <u>it activates the whole emotional system</u>
  - **IN:** Evaluates the **<u>significance of information from senses and viscera</u>**
  - **OUT:** It creates the emotional response, it **rules the emotional behaviors** (stimulus' evaluation –both present ones and memory- and emotional behaviors and instincts)



The limbic system's structures - II

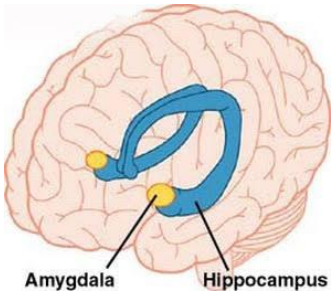


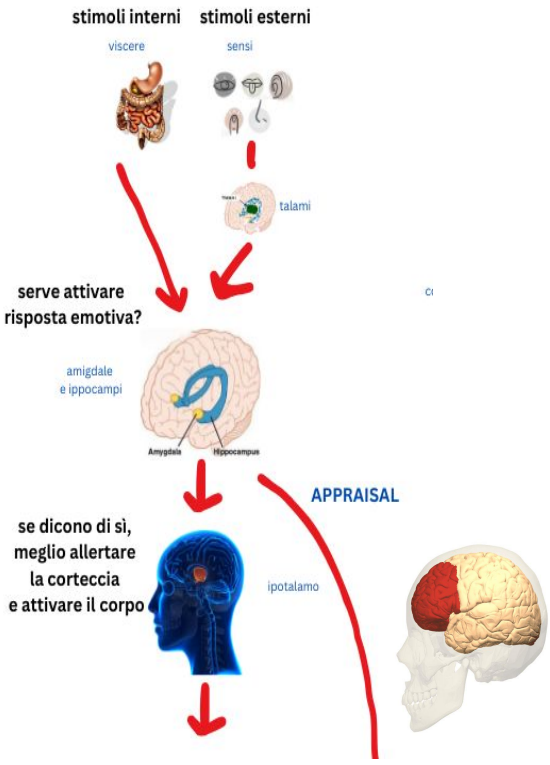
- **amygdalae (III)**
  - Plays a role *in **fear and anxiety*** (and thus (pertanto) in aggression)
    - The link between fear and aggression: we cannot understand aggression without taking into account being fearful and anxious!
    - If neurons do not have to be scared, they will not generate aggression

*amygdalae get bigger in **PTSD** patients - Plays a role also in sexual motivation among males: think about primates and men with sexual pathologies involving aggression*

The limbic system's structures - III

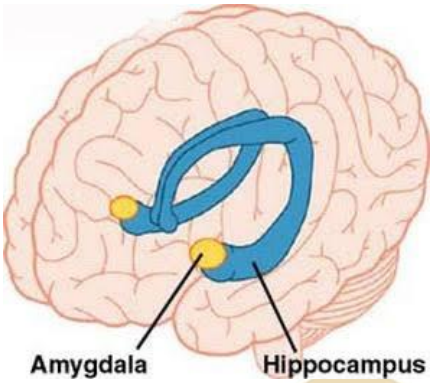
- **Hippocampus(es):**
  - Means "cavalluccio marino" (but looks like a "roll" involtino)
  - Big structure that terminates with the amygdala
  - Famous for being involved in learning and memory processes
  - **IN**: it scans the **emotional memories** (in order to find similarities with previous experiences)
  - **OUT:** Help **amygdala** to understand the **emotional significance of stimuli**





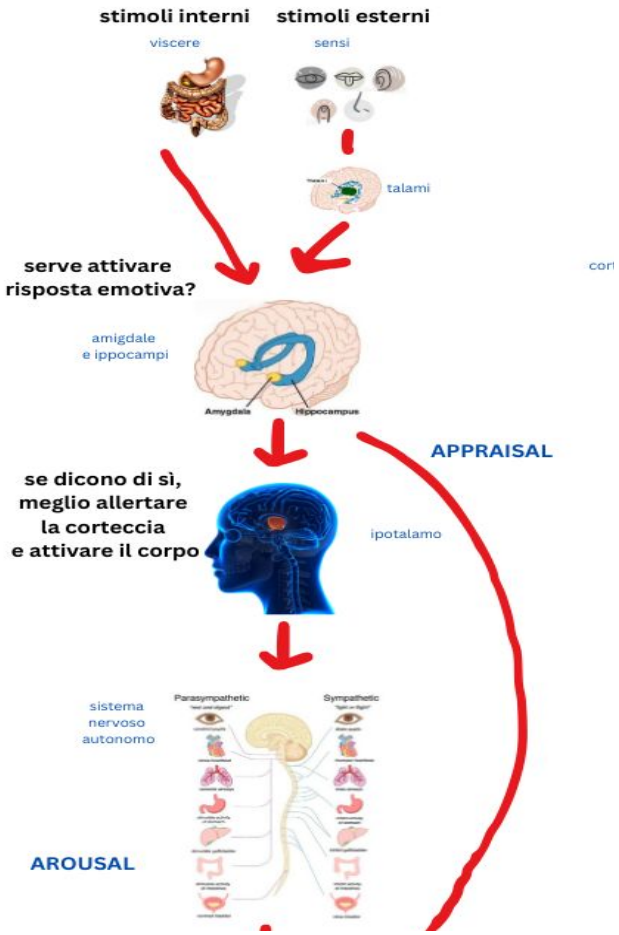
The limbic system's structures - III

- **amygdala(e)** and **hippocampus(es)**
  - IN: receive, combine and integrate information from the senses and from the viscera
  - OUT: Send information **to the cortex or to the hypothalamus** for the «output»



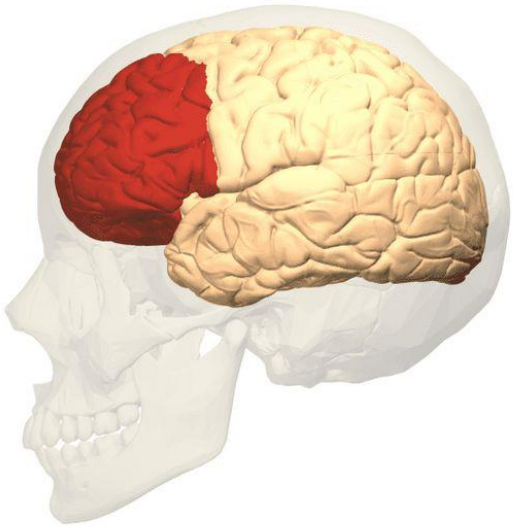
The limbic system structure - IV

- **Hypothalamus (uno!)**:
  - Means «under the thalamus(es)»
  - IN: Receives information from the limbic system
  - OUT: coordinates the Autonomic Nervous System **(endocrine system)**
    - regulates, through a complex **hormonal activity**, various functions of the body linked to emotions (temperature, metabolism, etc.)
  - Connections between hypothalamus, Autonomic NS and endocrine system are **bidirectional**!



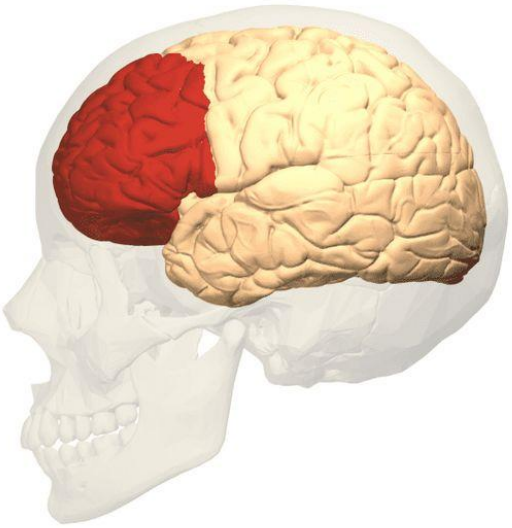
Pre-frontal cortex(es) - I

- Is now considered as part of the Limbic system as it is strictly connected to all its regions
- **IN**: all the rest of the Limbic system!
  - Information concerning the state of our body come from the amygdala and hippocampus and thalamus to the cortex, so that we can choose the best behavior to act
- **OUT**:
  - Plays a role in **emotion *regulation*, impulse control, long term planning**
  - **Decision making process based on emotions**!



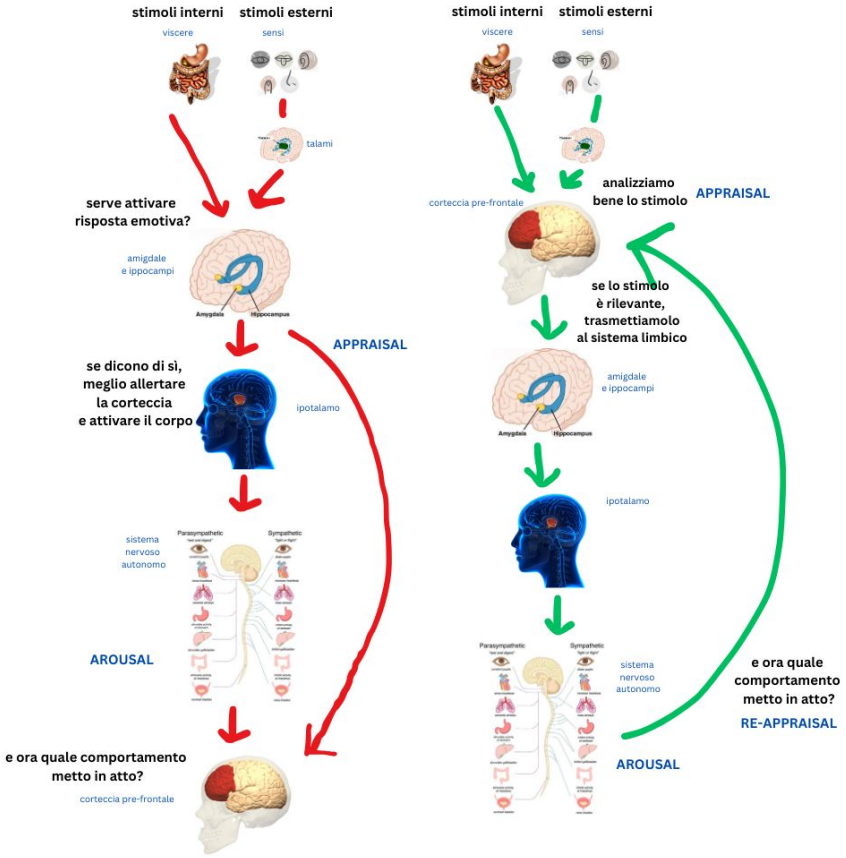
Pre-frontal cortex(es) - II

- It responsible for:
  - **regulating social interactions**, appropriate behaviors and social intelligence
  - **creating of stable affective styles**
- **Very "human" part**
  - The last one that was develop in evolution
  - The last one that develops in every individual (at around 25 years old!)
  - The dimension of the prefrontal cortex is linked to the size of the social groups
  - Linked to appropriate sexual behaviors
  - different from mammals. We are more able to <u>postpone our gratification</u> if needed



The case of Phineas Gage

Recent studies showed that the **cerebellum** could also play a role in the emotion regulation



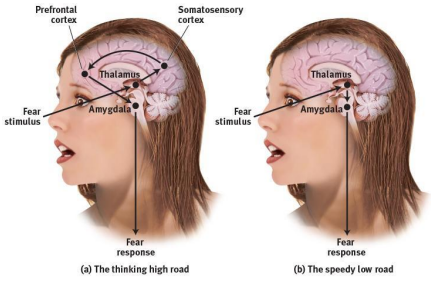
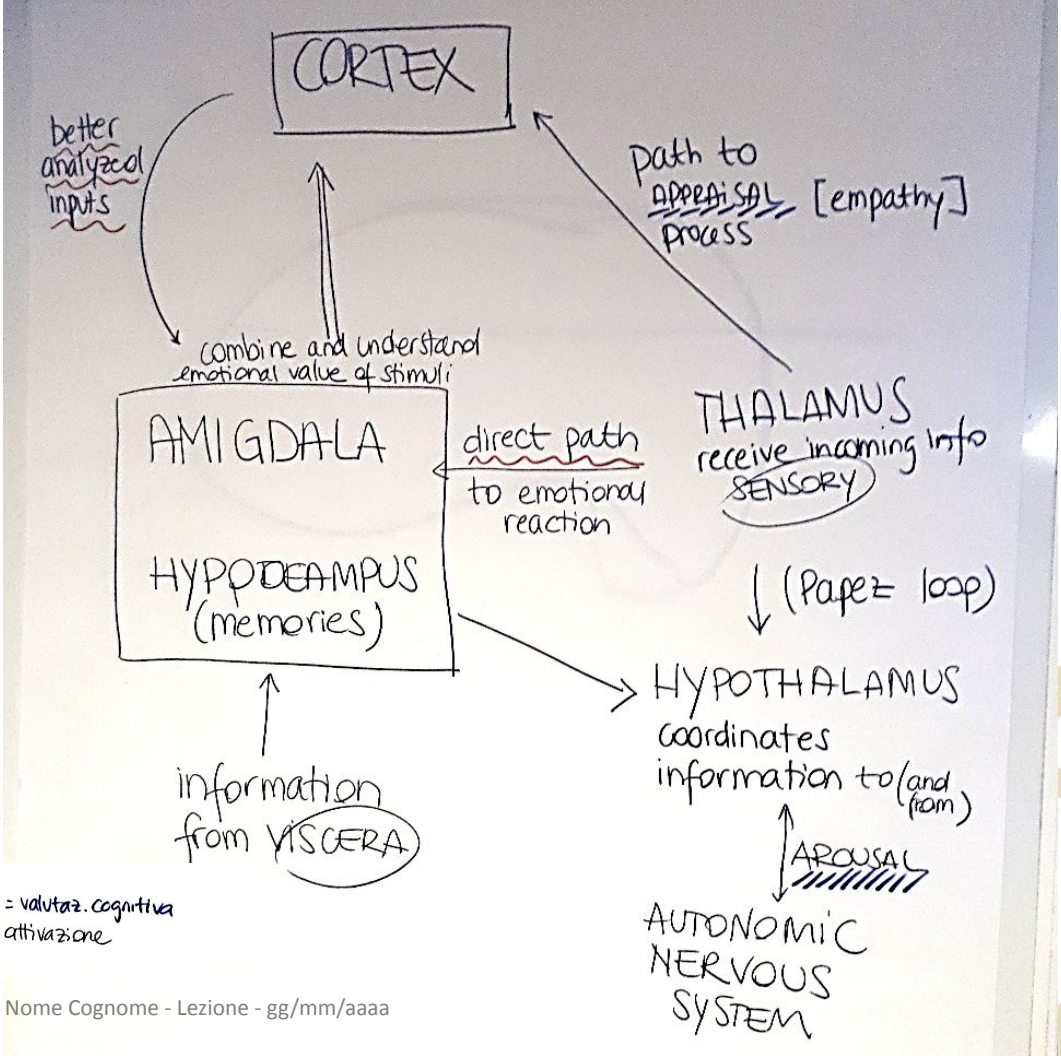


Figure 9.10
Myers/DeWall, *Psychology in Everyday Life*, 4e, © 2017 Worth Publishers

via breve (low road)

via lunga (high road)



Main brain areas involved

- Thalamus(es)
  - Central station of sensory information coming to the brain
- Hypothalamus
  - Receives information from the limbic system and coordinates the Autonomic Nervous System and the endocrine system
  - Responsible for the AROUSAL
- Hippocampus(es)
  - Deputed to **emotional memories: c<u>onnections between memory and emotional circuits</u>**
- amygdala(s)
  - **«the emotional computer»**
  - **integrates sensory and memory information** and activates the whole emotional system
  - **updates the cortex on the present emotional status** (especially for fear and anxiety)
- Pre-frontal Cortex(es)
  - Plays a role in emotion regulation, impulse control, long term planning
  - **It selects appropriate behaviors**
  - Decision making process based on emotions!
  - **modulates the level of the activation for the amygdala based on the information from the environment (personal, social, etc.).**

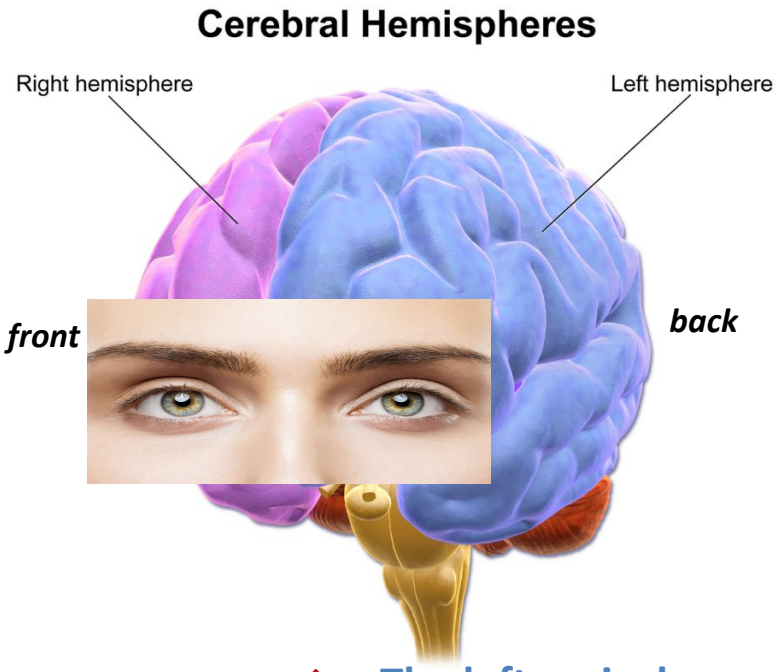
It is a matter of brain connections!

- The "model of locations" is not accepted anymore The fact of describing every single part of the system is a simplification!
- **It is the interconnection between all the areas that plays a difference**, not the single area *per se*
  - Connection can be automatic
  - Or driven

- Why are all these connections important?
  - Because the richness of reciprocal connections between structures **increase the complexity of the system**
  - Because all these communications **help the signals** from the limbic system **to be vastly distributed**
  - Because of the **hierarchical organization** (where cortical parts have a control and modulation role over the –*sulle*- other parts)

Left and right brain

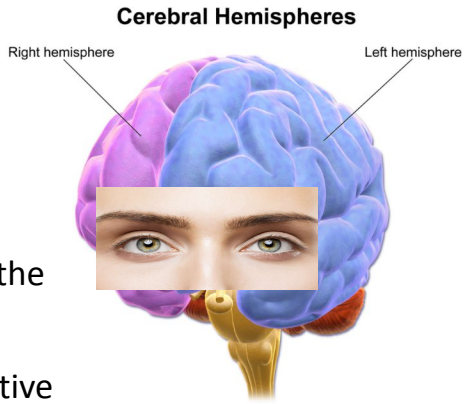
- The right **hemisphere**
  - Spatial and musical activities
  - Response to emotions



They have slightly different competences concerning emotions

- **The left emisphere**:
  - Language
  - Praxic (commands for movements)

Left and right brain



- The right **hemisphere is predominant** in the
  - **Emotional identification** (faster and more accurate in the right brain, especially if information are linked to perception)
  - **emotion manifestation and facial expression** (both active -when we show emotions-, and passive -when we watch somebody else's emotions-) because
    - it is more able to decode faces and voices
    - The left part of the face is more expressive
  - **for negative emotions tendency to «avoidance» and «withdrawn»**

- **The left emisphere** is predominant for **positive** ones
  - Because they are linked to **communication** (verbal and emotion communication) more than the negative ones
  - Tendency to «Approach» (positive emotions)

Recent research discovered the existence of mirror neurons also for emotions!

LET'S GET PRACTICAL

- What do we learn from physiology of emotions, as educators?