

**GERHARD ROTH and NICOLE STRÜBER**

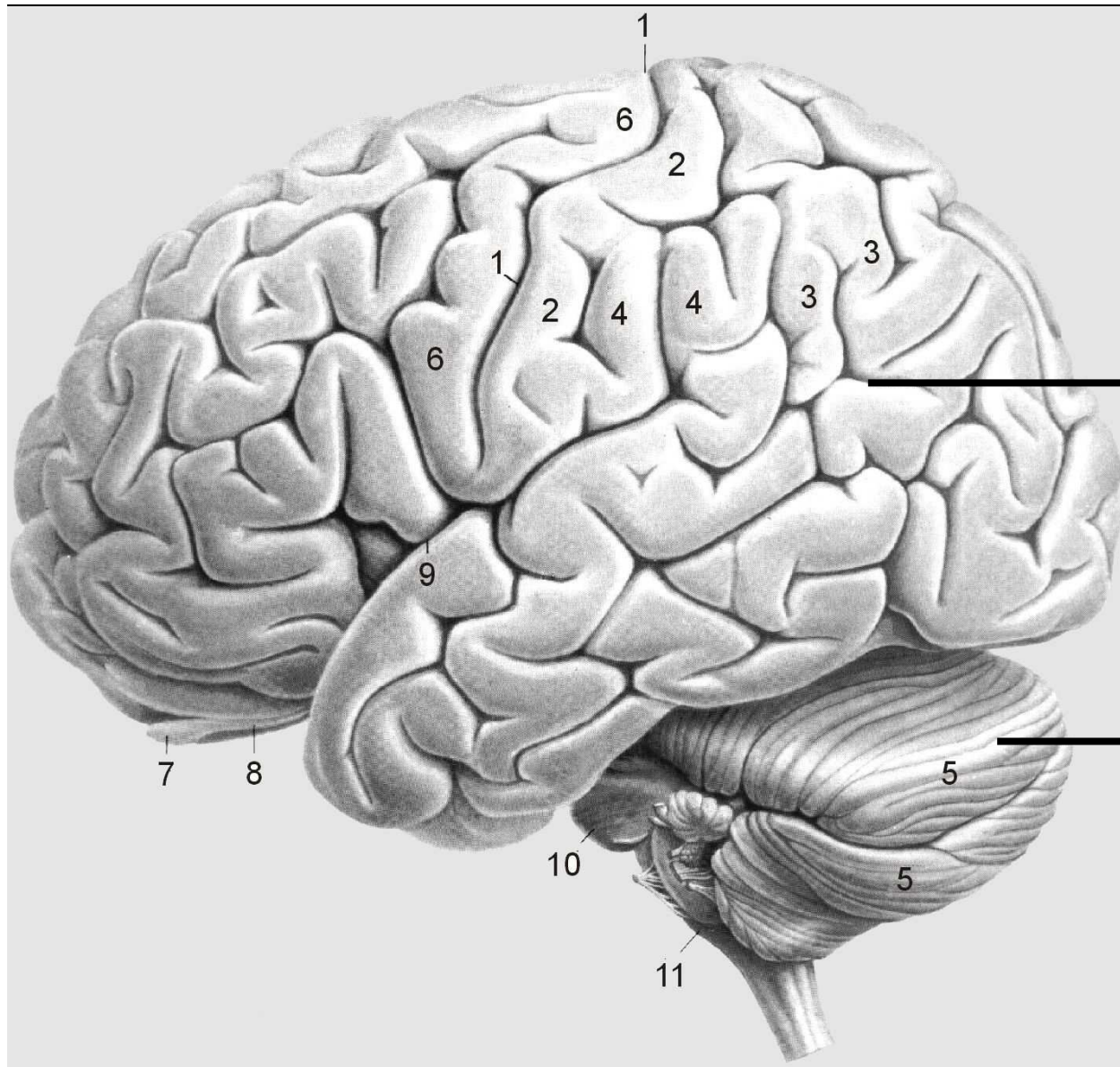
**THE DEVELOPMENT OF PERSONALITY AS A  
PROCESS OF SELF-ORGANIZATION**

**BRAIN RESEARCH  
INSTITUTE  
UNIVERSITY OF  
BREMEN**



# LATERAL VIEW OF THE HUMAN BRAIN

Weight 1.4 kg  
About  $8 \times 10^{10}$  neurons  
and about  $10^{15}$  synapses



CORTEX

CEREBELLUM

Brains are self-producing and self-organizing systems par excellence.

Their structures, connectivities and functions develop by

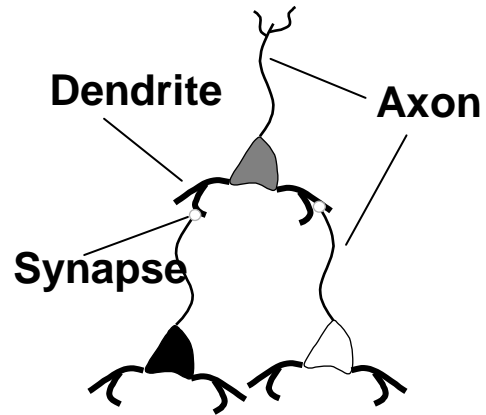
- genetic and epigenetic information
- influence from the environment including body
- experience and use.

The interaction of the brain with the environment begins before birth



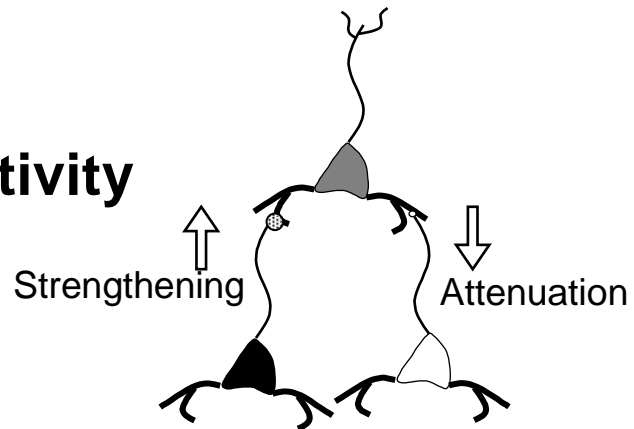
# EARLY LEARNING AND BRAIN MATURATION

**A**



**Coarse connectivity**

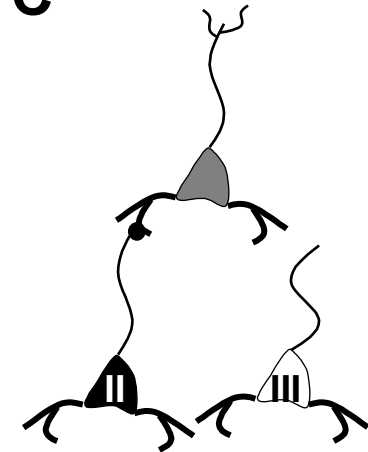
**B**



**Environment**

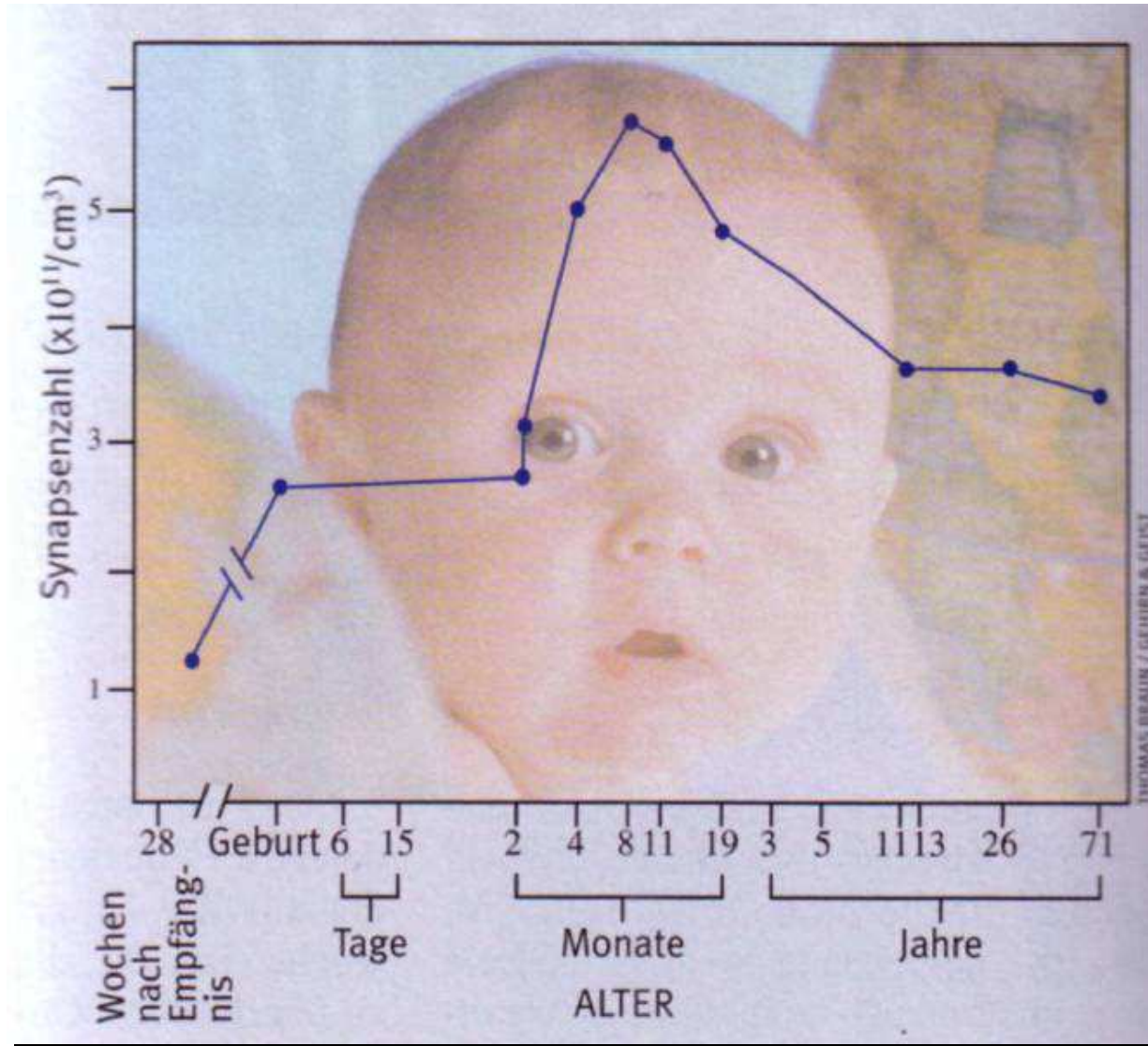
emotional Experience,  
Learning, Education  
Self-induce activity

**C**



**Fine connectivity**

# Development of synapses during life time



From a neurobiological perspective, personality traits are constituted by the following factors:

- Genetic pre-dispositions (polymorphisms)
- Brain development
- Prenatal, perinatal and early postnatal experience (attachment experience, psychotraumatization)
- Early psychosocial experience in family, school, peer group etc.
- Education and later social experience

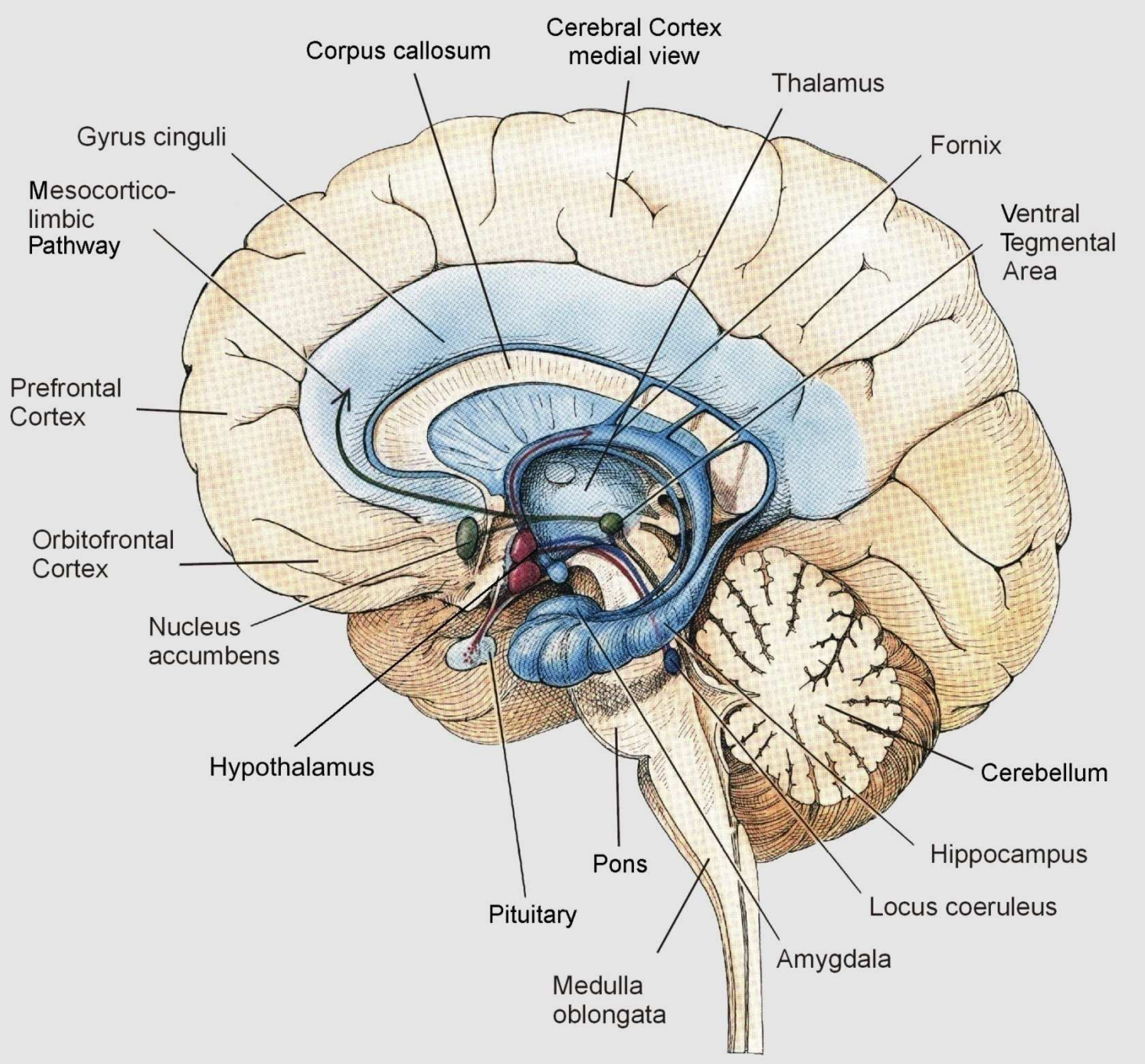
These factors determine and influence the human brain at different anatomical and functional levels, which develop at different times during brain development.

# **LEVELS OF PERSONALITY IN THE HUMAN BRAIN**



Medial view of the human brain

**LIMBIC SYSTEM**



## Deep limbic level

Level of unconscious, mostly stereotyped reactions and drives: sleep-wake, feeding, sexuality, fight-flight, dominance, territoriality, rage etc; with strong sexual dimorphism.

Centers: Hypothalamus/preoptic region – periaqueductal gray – autonomic brainstem centers.

Processes at this levels are predominantly genetically determined and constitute our *temperament*.

They develop long before birth and are not or only minimally influenced by experience and education.



Autonomic  
functions and  
stress regulation

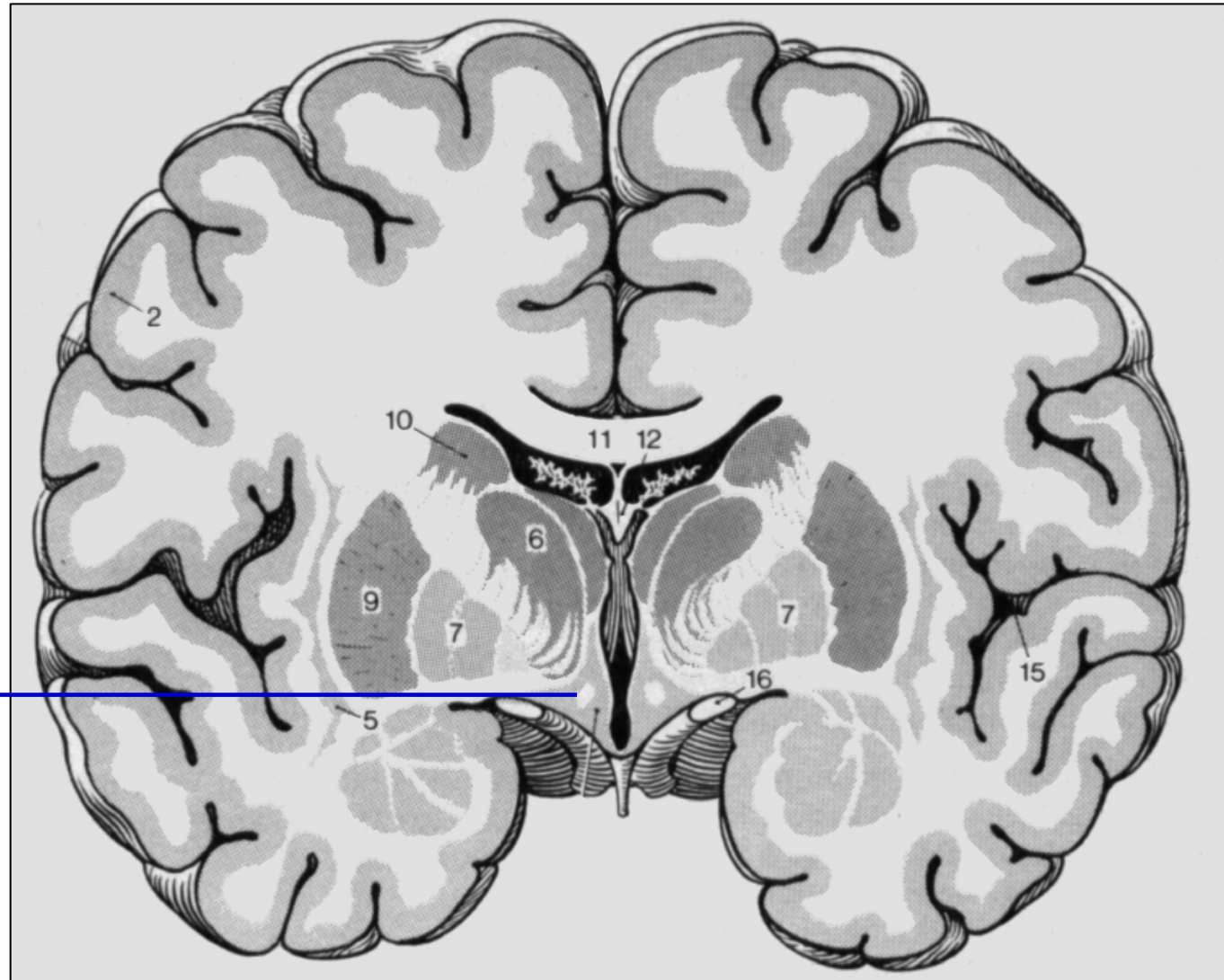
Feeding  
behavior

Territoriality

Aggression

Sexuality

Hypothalamus



## Medium limbic level

Level of unconscious emotional conditioning, i.e. connection of elementary emotions (fear, happiness, contempt, disgust, curiosity, hope, delusion etc.) with events of individual life.

Main centers: Amygdala, mesolimbic system (ventral tegmental area, nucleus accumbens).

This level, together with the deep limbic level, constitutes the *unconscious part of our self*. It develops, together with the first level, before and in the first months and years after birth and stabilizes itself.

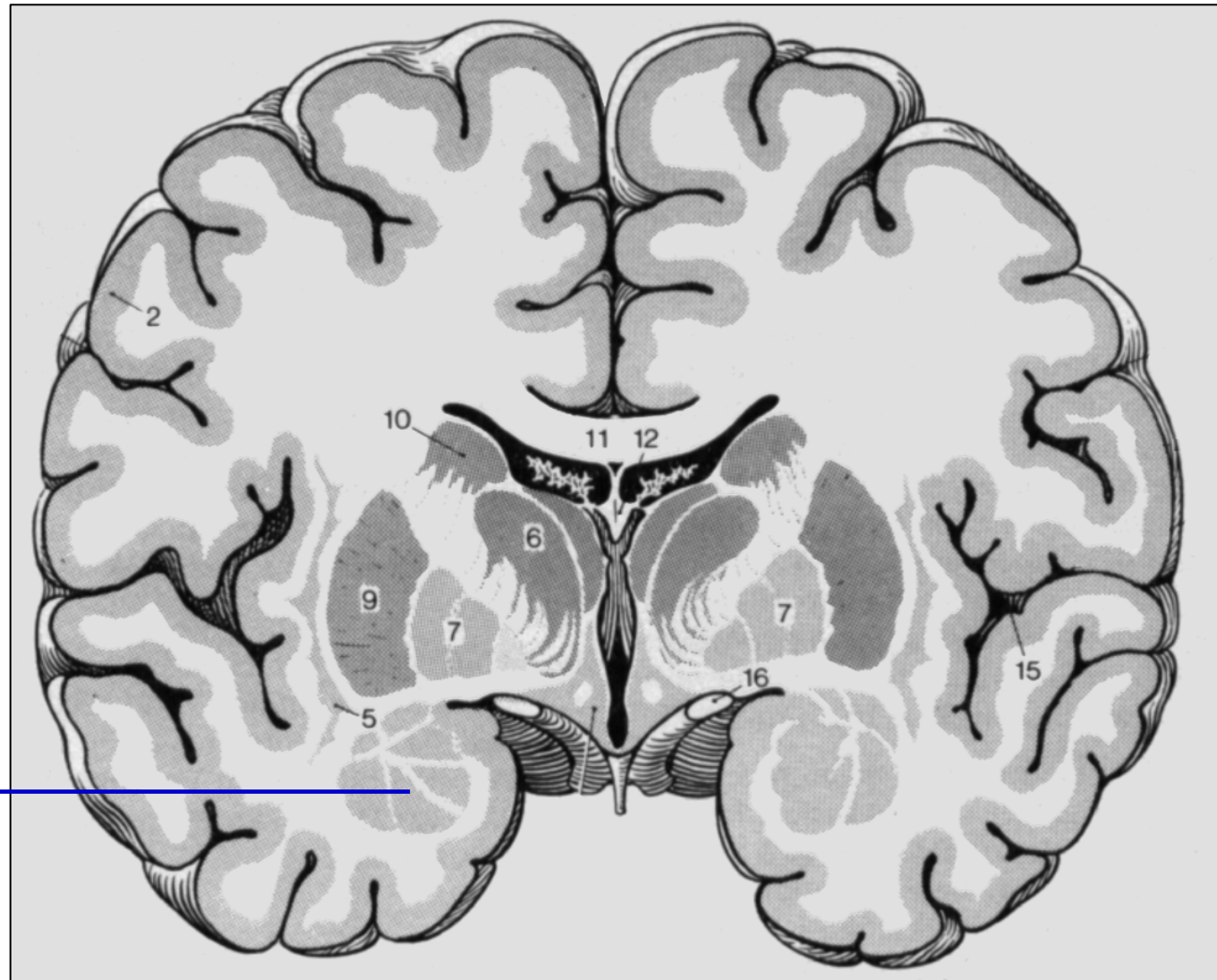
During puberty, it again undergoes some dynamic changes, but then becomes strongly stabilized and can be modified only by strong and/or long-lasting emotional events.



## AMYGDALA:

Center for  
innate emotions  
and emotional  
conditioning

Amygdala



## Recognition of emotional-communicative signals

(faces, gestures, body posture, pheromones)

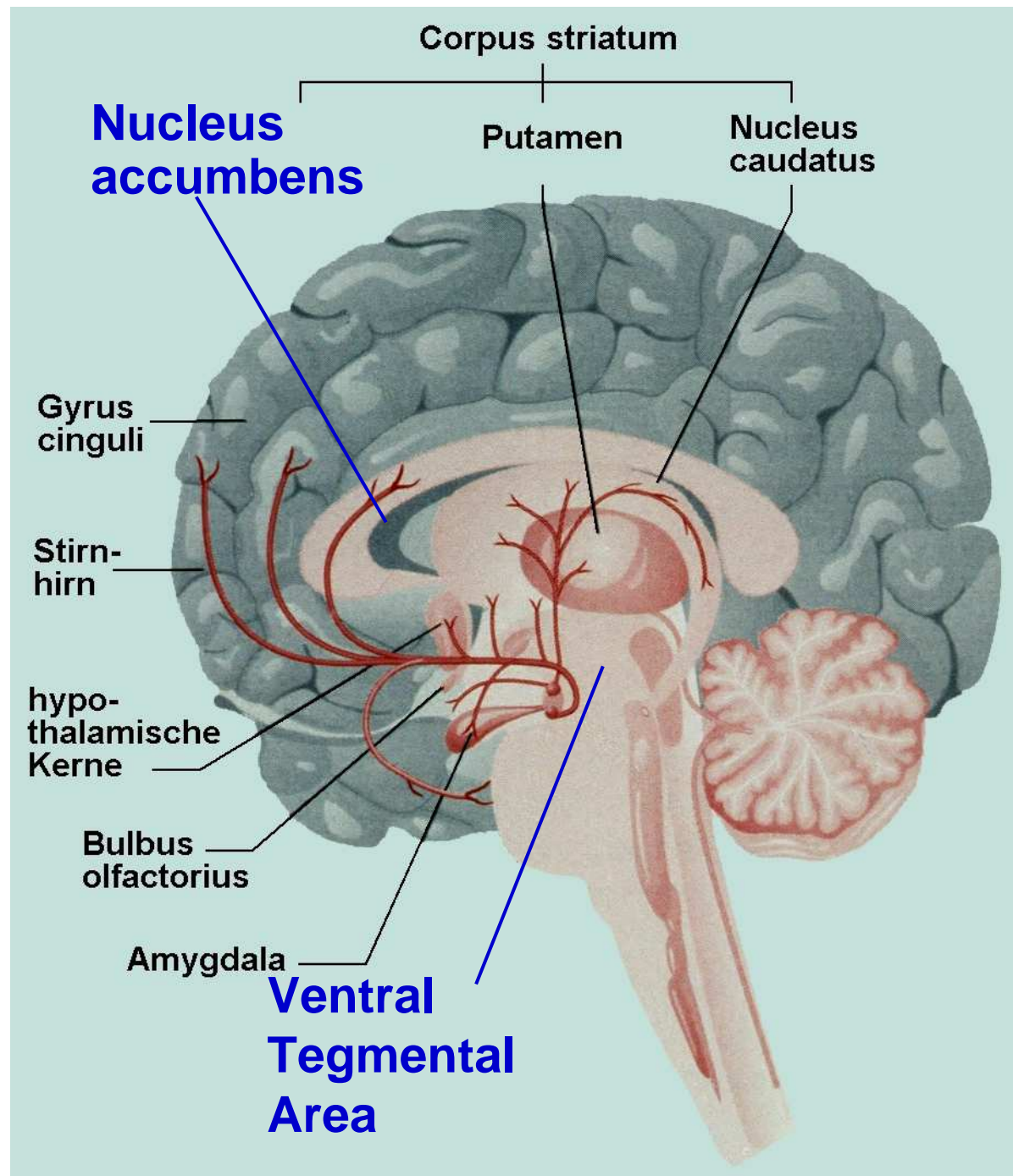


## Mesolimbic System:

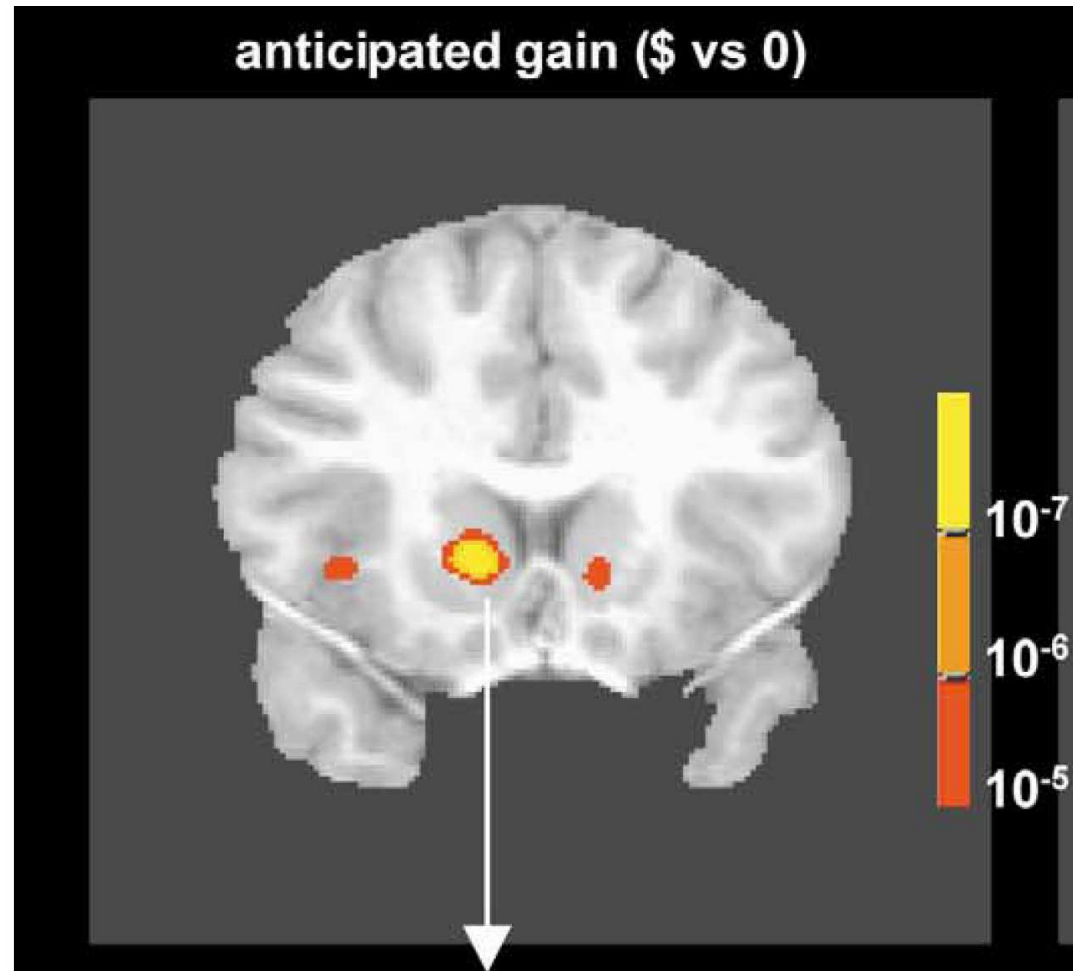
Responses to unexpected events

Reward expectation system: **Dopamine**

Reward system: **Endogenous opioids, cannabinoids etc.**



## Activation of the mesolimbic system (VTA-Nucleus accumbens) at reward expectation



*Knutson B. et al. (2003) Neuroimage, 18:263-272.*



## Upper limbic level

Brain: Pre- and orbitofrontal, cingulate and insular cortex.

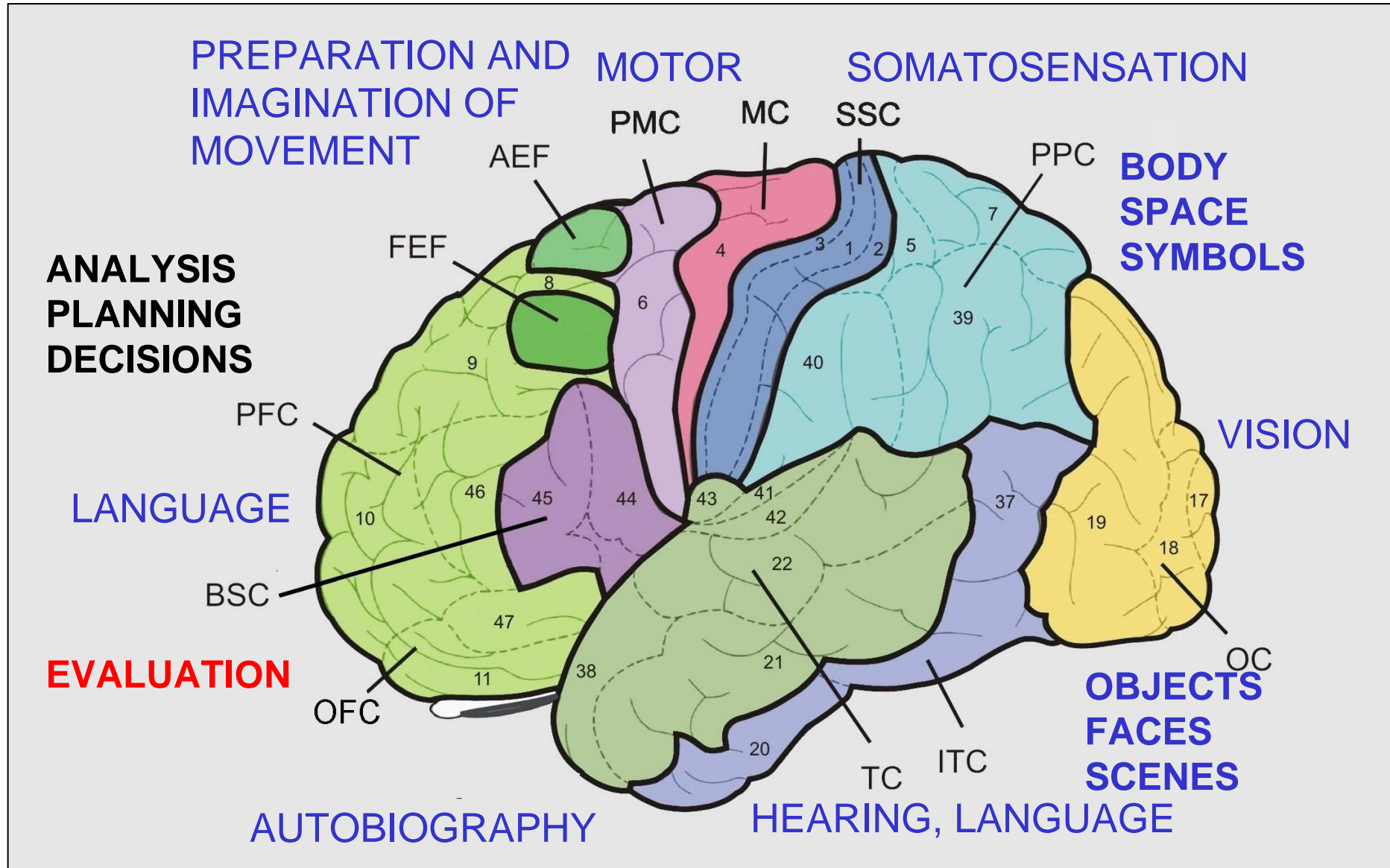
Level of conscious emotional-social learning: Pursuit for success, power, profit, recognition-fame, friendship, love, acceptance, moral, ethics.

This level develops in late childhood and adolescence. It is mostly determined by social-emotional experience and can be changed primarily by this type of experience. It remains plastic until early adulthood and then stabilizes.

One important function is the social control of processes at the deep and medium limbic („egoistic-impulsive“) level



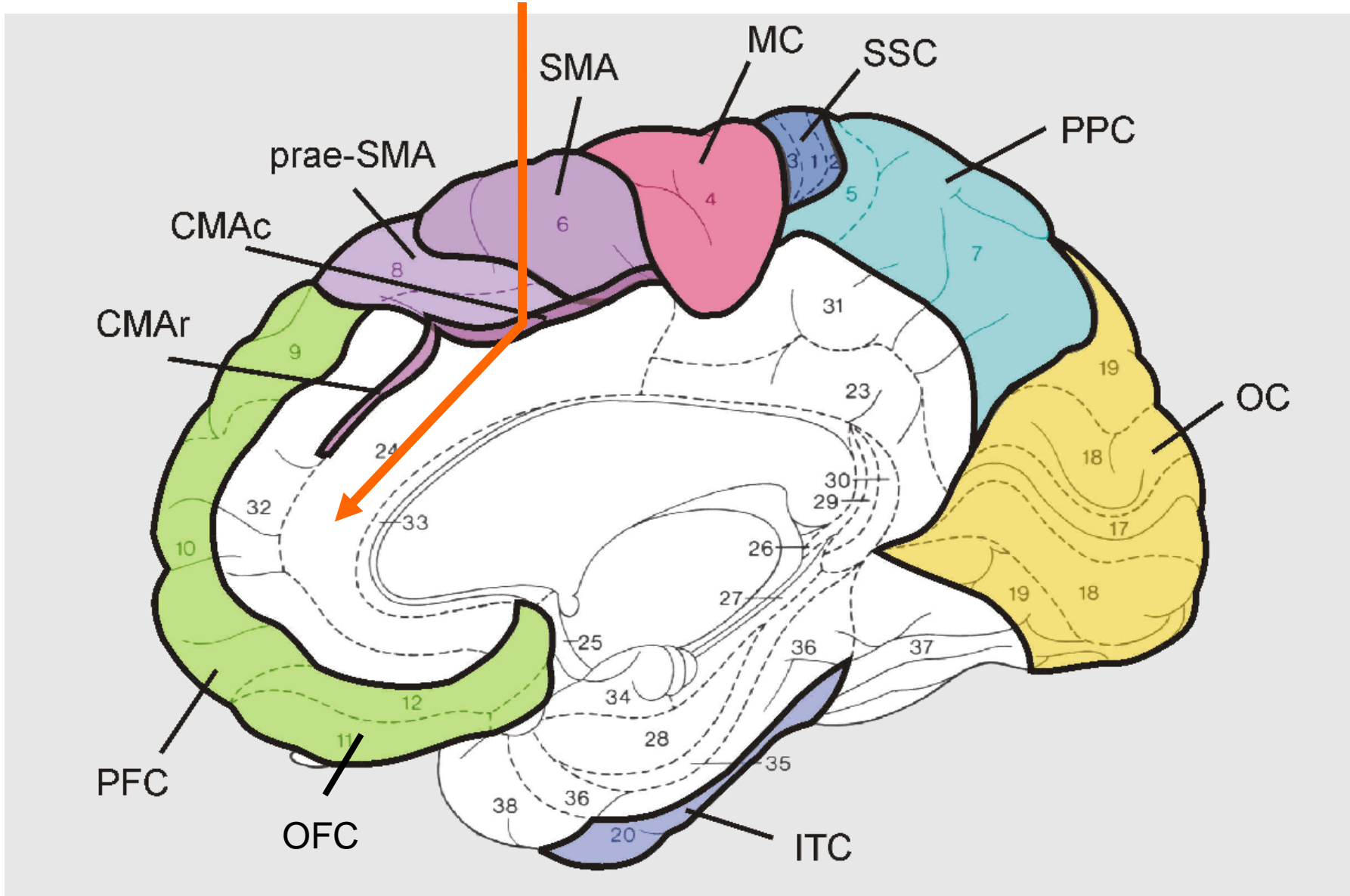
# FUNCTIONAL ORGANIZATION OF THE CEREBRAL CORTEX



## **FUNCTIONS OF THE ORBITOFRONTAL CORTEX**

- Conscious perception of emotions
- Emotional preparation and motivation of actions
- Assessment of **consequences** of one's own behavior and of individual and social **risks**
- Identification of the **emotional expression** and of the meaning in the actions of others (**empathy**)
- Learning and control of **socially adequate behavior**

# ANTERIOR CINGULATE CORTEX



## FUNCTIONS OF THE DORSAL AND VENTRAL ANTERIOR CINGULATE CORTEX

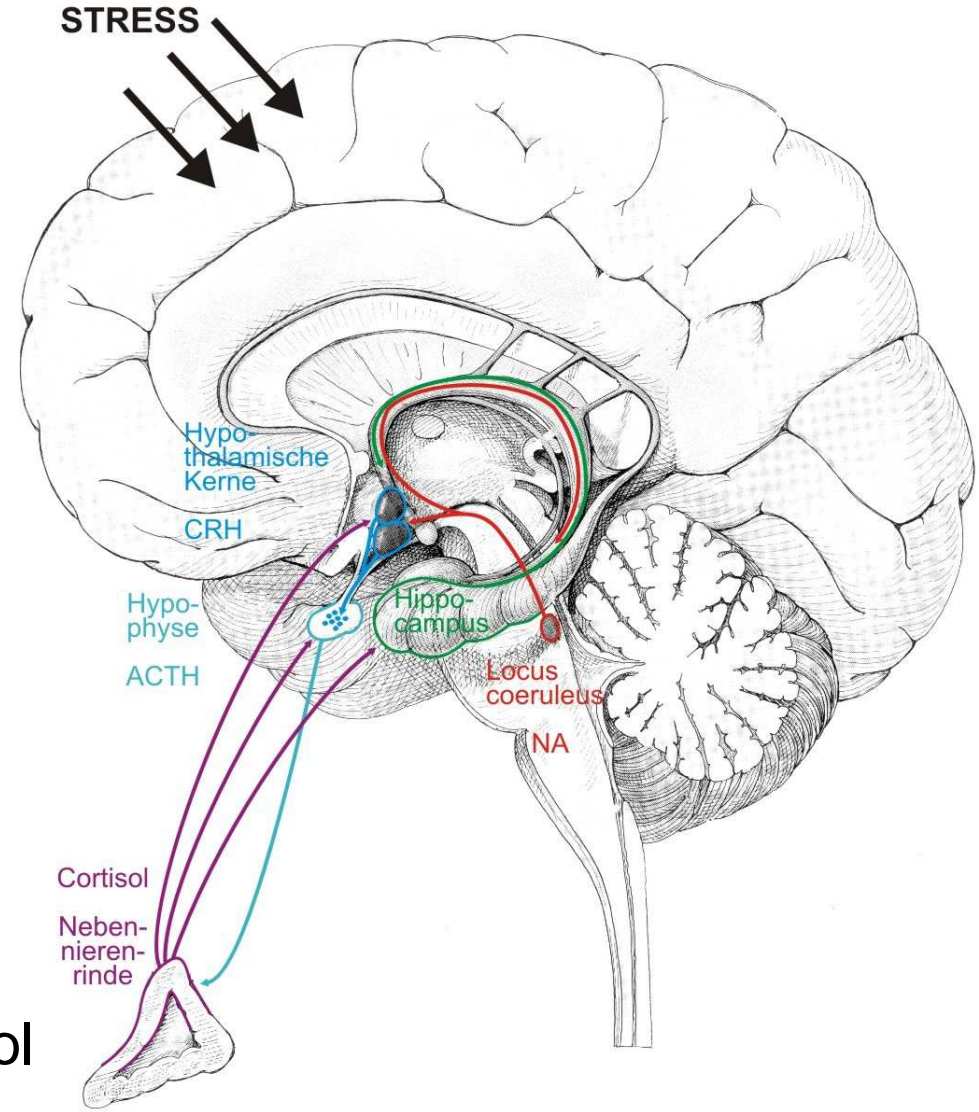
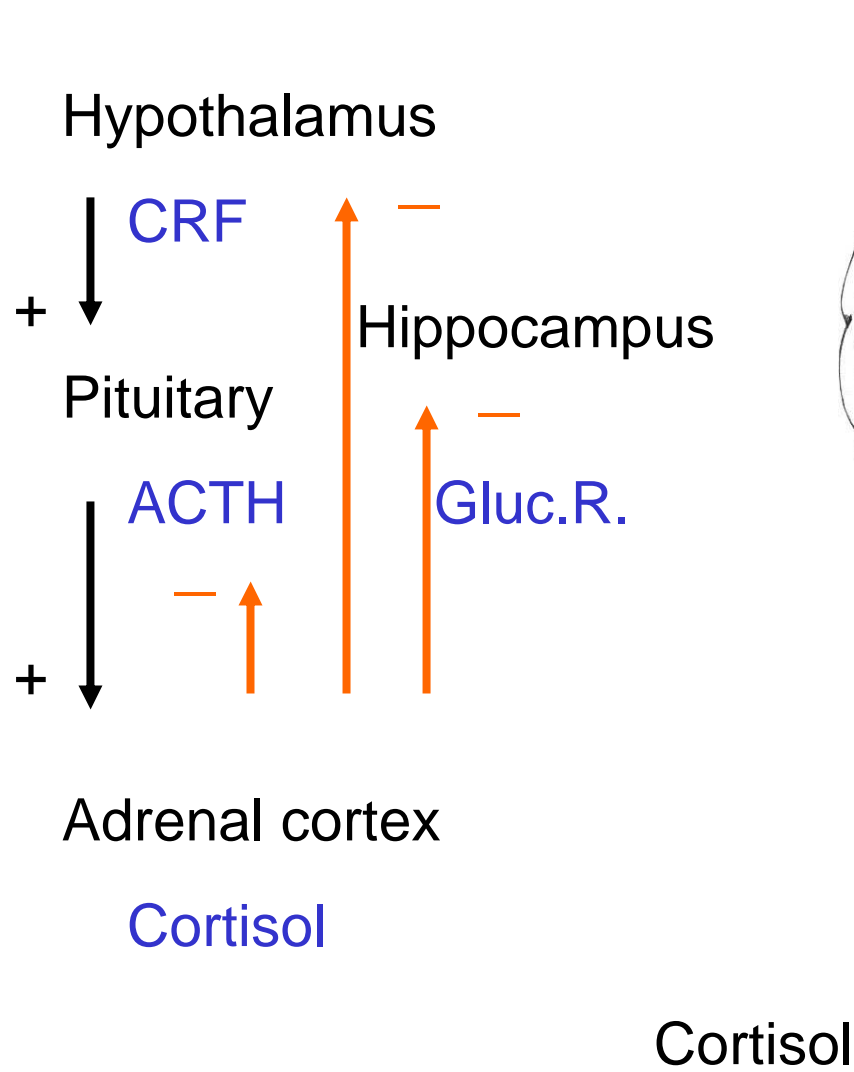
- **Dorsal:** Control of externally and particularly **internally driven attention**
- **Dorsal** **Error monitoring**
- **Ventral:** Processing of affective and emotional components of **pain** perception
- **Ventral:** Evaluation of **reward** and **punishment**
- **Ventral:** Emotional assessment of **future rewards** and **risks**
- **Ventral:** Control and retrieval of emotional memories

## **IMPORTANT STEPS IN PSYCHO-NEURAL DEVELOPMENT OF PERSONALITYES**

- Development of stress-management system (stress axis; prenatal and early postnatal)
- Development of the system of self-regulation (prenatal, early postnatal)
- Development of the attachment system(first postnatal years)
- Development of impulse inhibition system (1-20 year of life)
- Development of empathy and theory of mind (3-20 year of life)
- Development of reality awareness and risk assessment (3-20 year of life or later)

# „STRESS AXIS“

Negative CRF-ACTH-cortisol feedback loop between adrenal cortex, hypothalamus and hippocampus

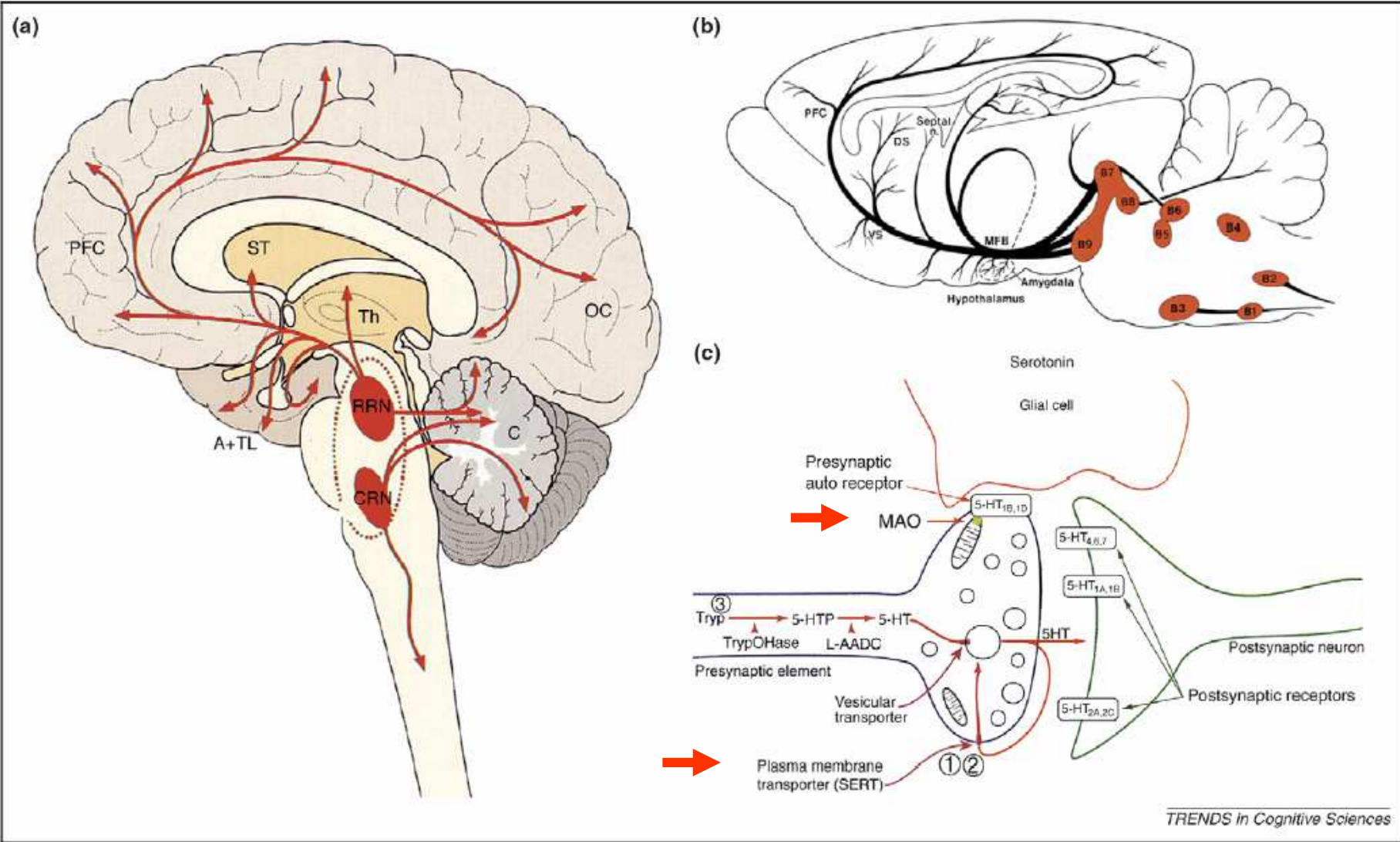


## CONSEQUENCES OF EARLY STRESS ON HPA AXIS

- Reduced glucocorticoid (GR) receptors in hippocampus
- Inhibition of neurogenesis (granule cell precursors) in hippocampus
- Breakdown of negative CF-ACTH-cortisol feedback
- Hypercortisolism
- Volume reduction of HC
- Increased amygdala activity, fear, anxiety and depression
- Hypervigilance



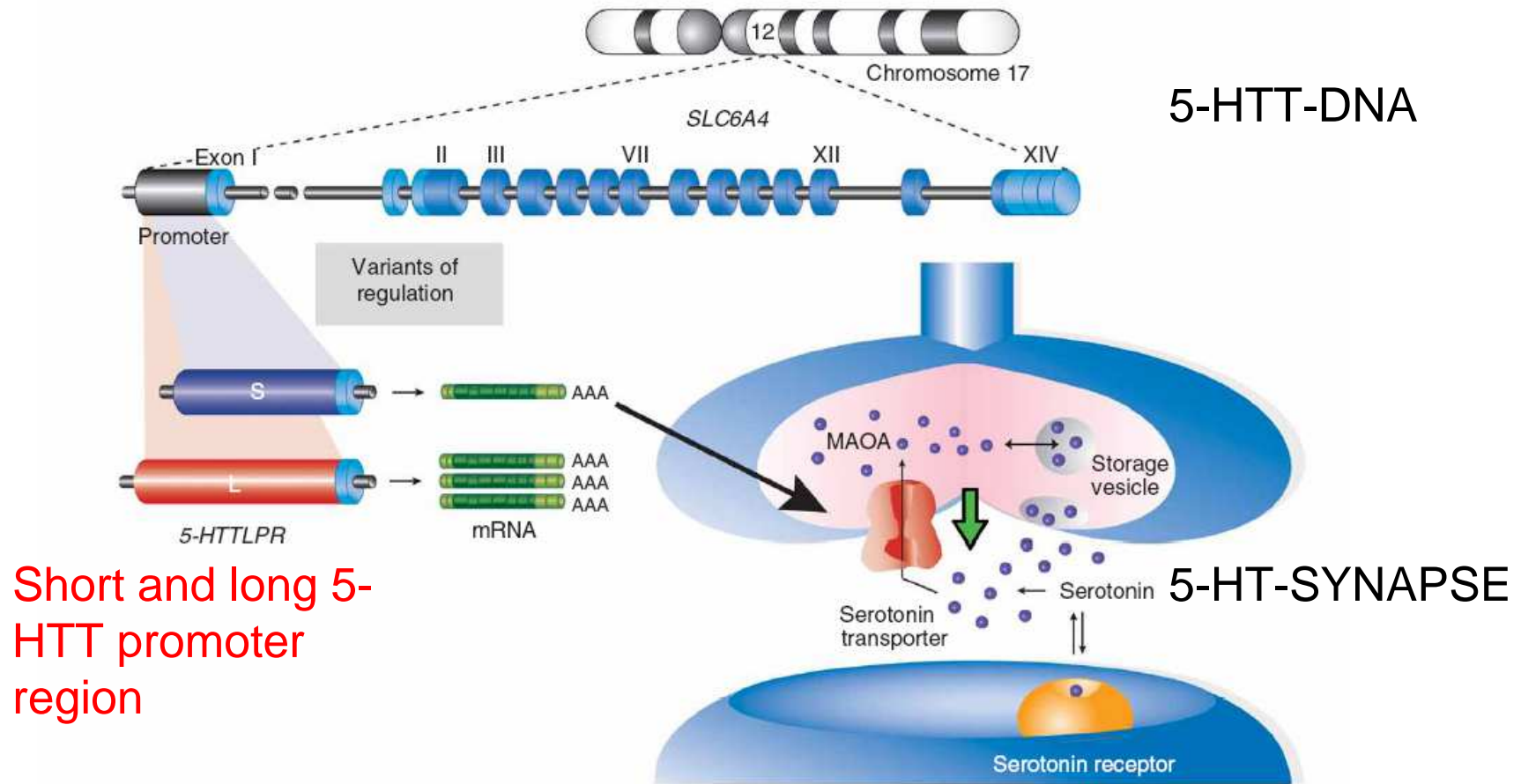
# SEROTONIN- (5HT-) SYSTEM



Cools et al., Nature Neuroscience 2007

# POLYMORPHISM OF 5-HT-TRANSPORTER GENE

Canli and Lesch, Nature Neuroscience 2007



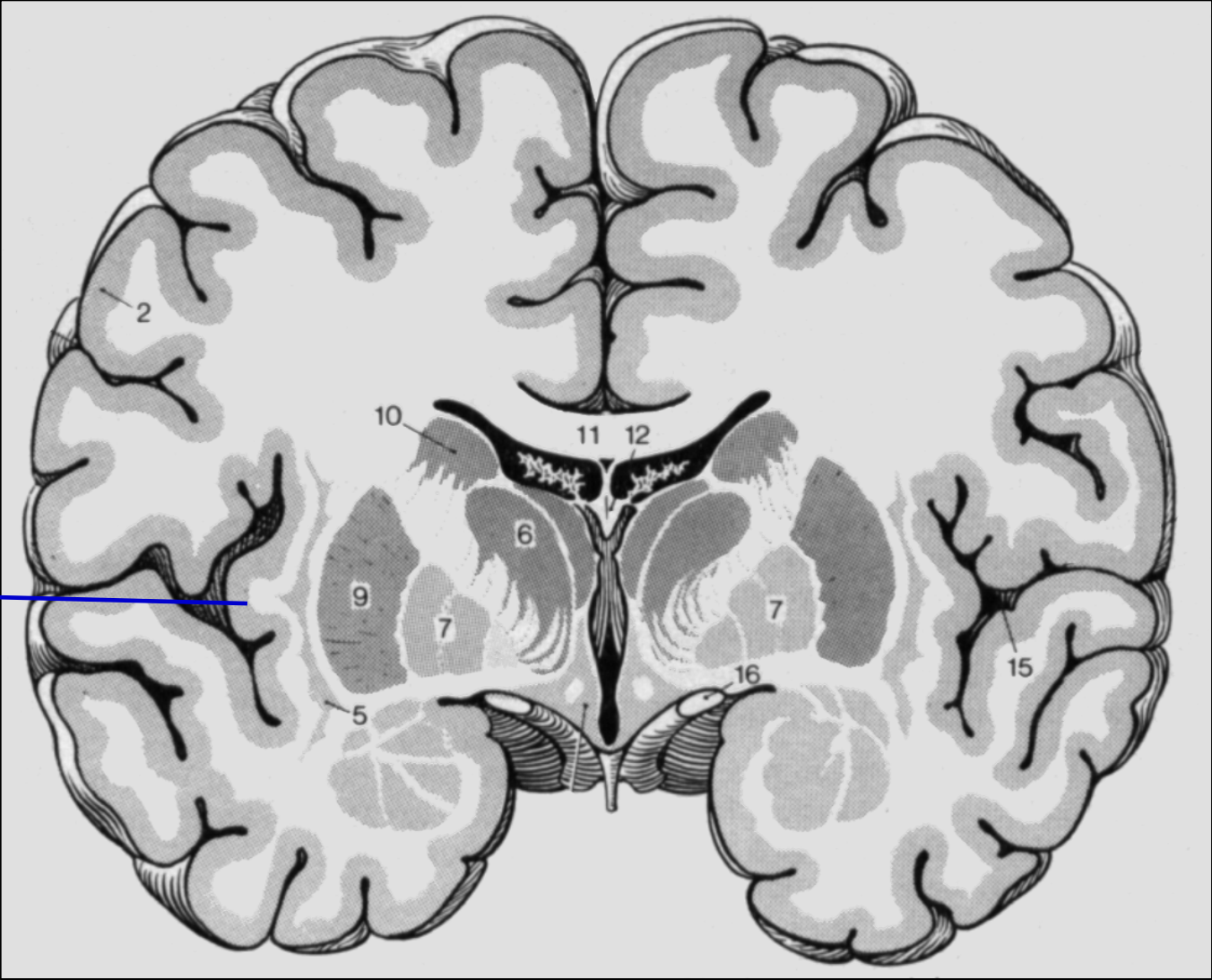
Short and long 5-HTT promoter region

The short variant of transporter gene is correlated with increased anxiety, depression and reactive violence as a consequence of increased feeling of being threatened and of reduced impulse control.

Early postnatal attachment experience is based on the release of oxytocin and endogenous opioids and is the most important experience in our life. Early attachment experience determines our individual and social behavior including self-esteem, self-confidence, partnership, parental care, empathy, theory of mind and responsibility.



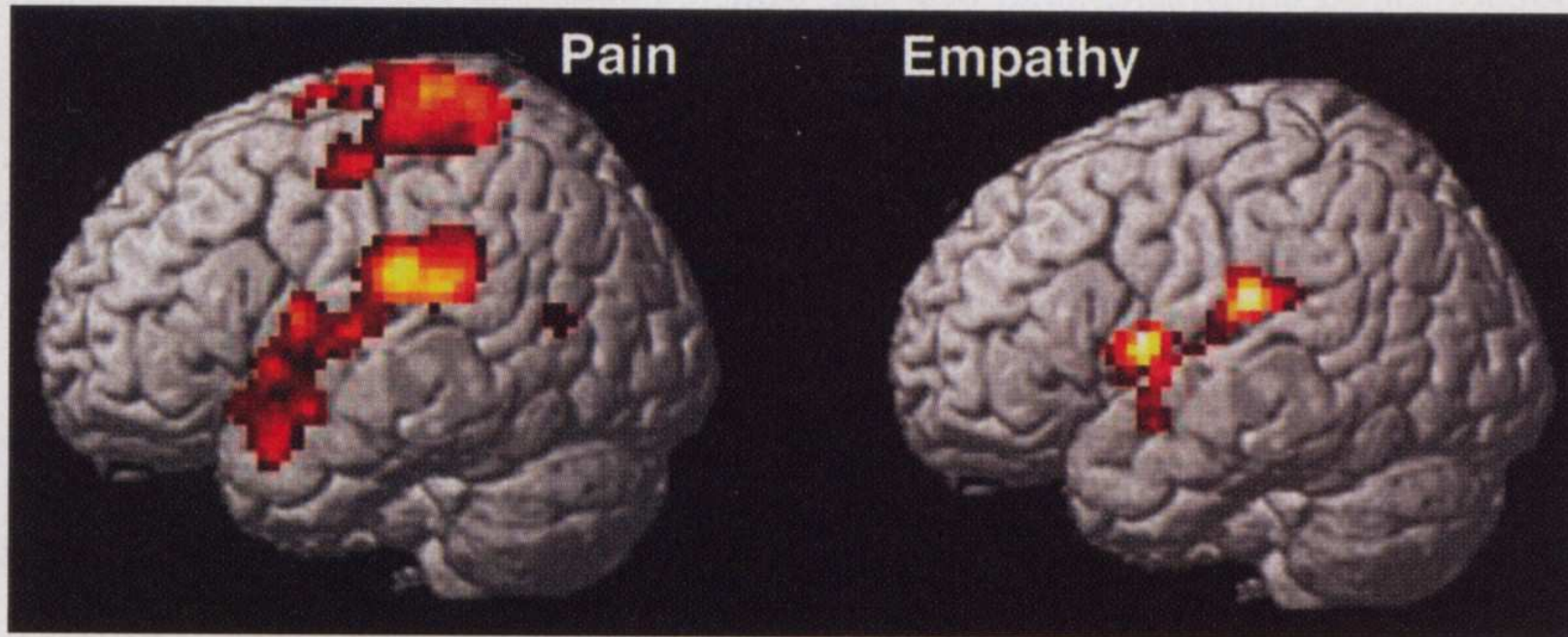
Insular  
cortex



# INSULAR CORTEX

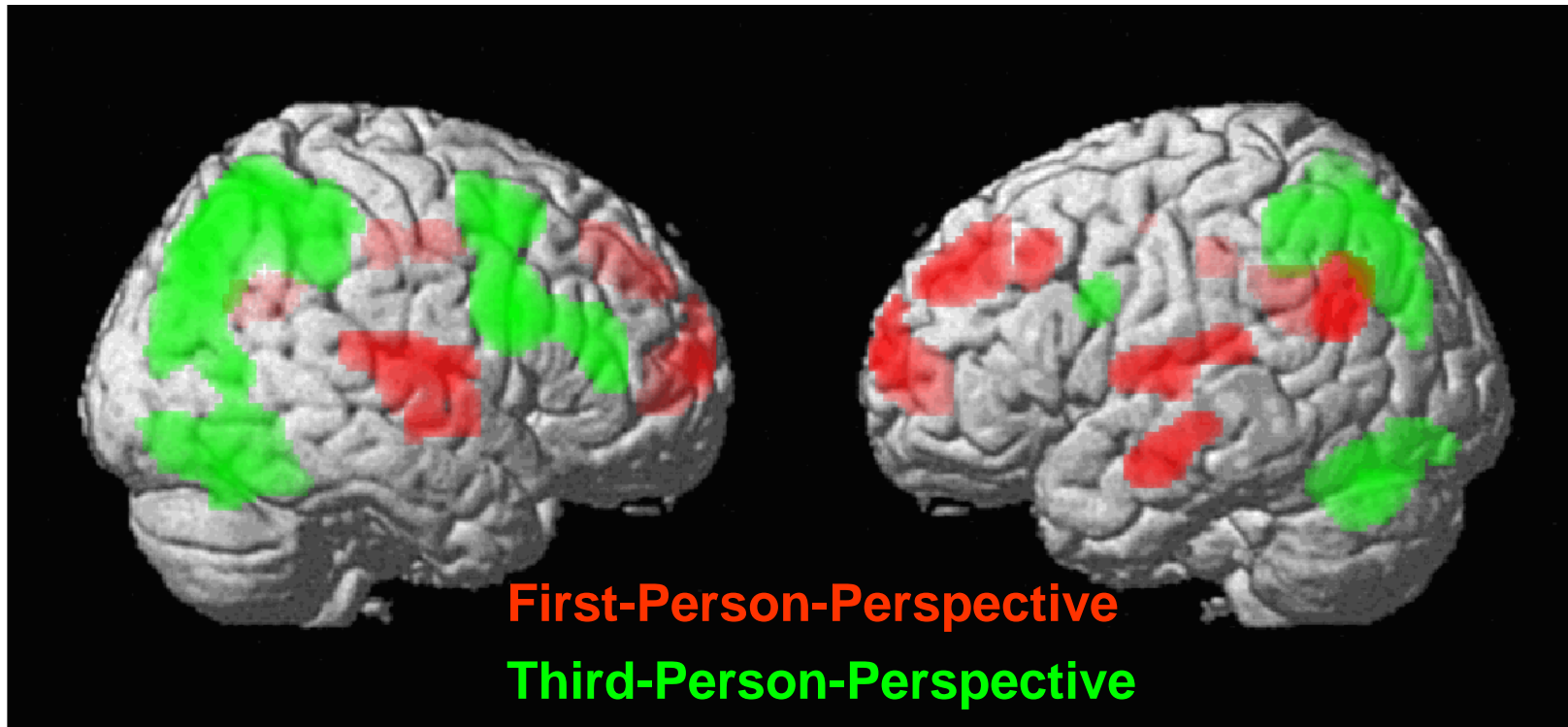
- Processing of gustatory and visceral stimuli
- Processing of **affective** and **emotional components** of **pain** sensation
- Identification of emotional content and meaning in the action of others (**empathy, theory of mind**)

## Self-experienced pain and Empathy

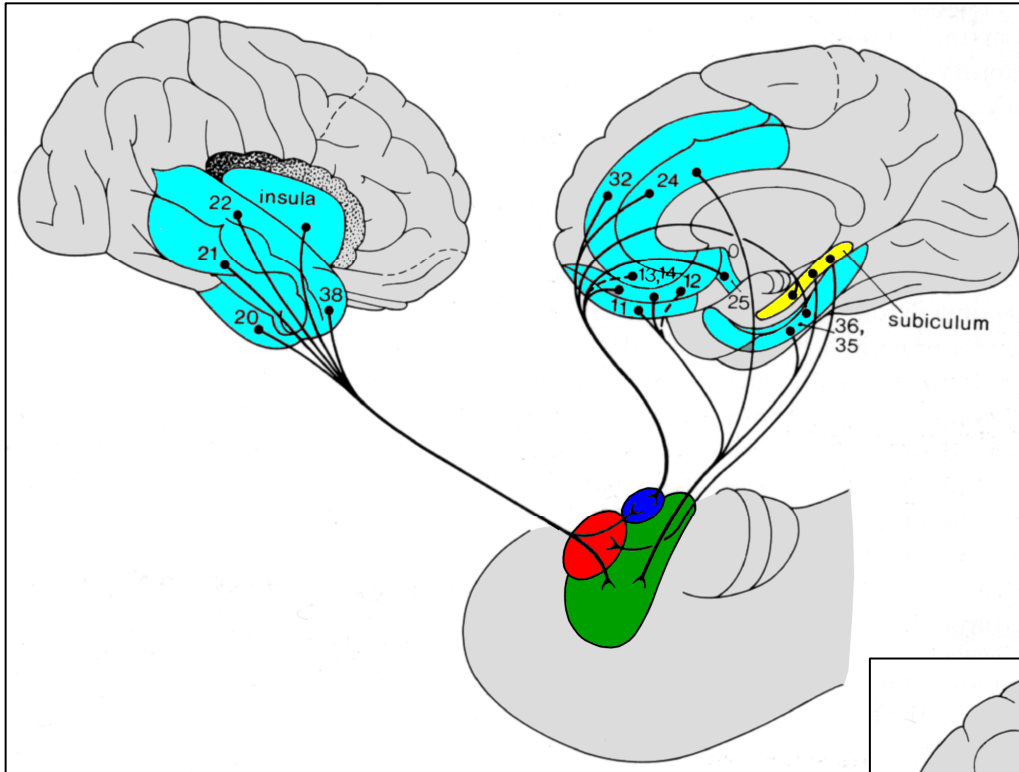


**Picture of pain.** Empathy for pain mirrors the suffering—but not the physical pain—in the same brain regions.

## CHANGE OF PERSPECTIVE

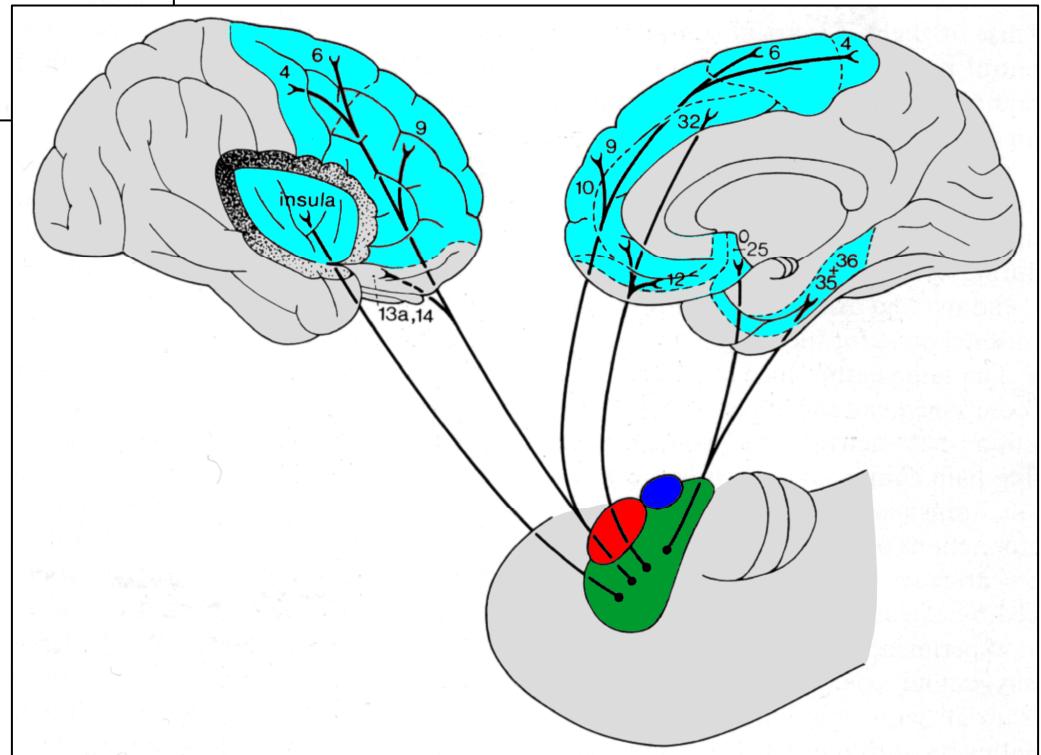


Vogeley et al., NeuroImage, 2001



Connections from cortex  
and hippocampus to  
amygdala = **INHIBITION**

Connections  
from amygdala  
to cortex and hippocampus  
= **EXCITATION**





## SUMMARY

Human personality develops at four anatomical-functional limbic levels and a combination of 6 psycho-neural systems (stress-management, self-regulation, attachment, impulse inhibition, empathy/theory of mind and reality awareness/risk assessment).

The development of these systems is strictly related to the full establishment of the neuromodulator-neuropeptide systems noradrenaline-cortisol, serotonin, oxytocin, dopamine, endogenous opiates and acetylcholin.

These 6 systems develop in consecutive steps, and each system largely depends on the sufficient maturation of the earlier one(s), and early deficits can only partially be compensated by later „normal“ development.

**THANK YOU FOR YOUR  
ATTENTION**