

Lectures

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Zespół Biochemii i Neurobiologii



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A fundamental goal of neuroscience is to understand how consciousness arises in the human brain and how brain damage alters or destroys it.

Studying consciousness is difficult since it is a subjective inner experience whose content is not measurable using scientific instruments.

Introspective, linguistic-based, inner thought stream that exists only in humans but not in any other animal.

Alternative explanations for consciousness range from quantum mechanics to dualistic religious traditions that hold that a nonmaterial soul is the real seat of conscious.



Consciousness

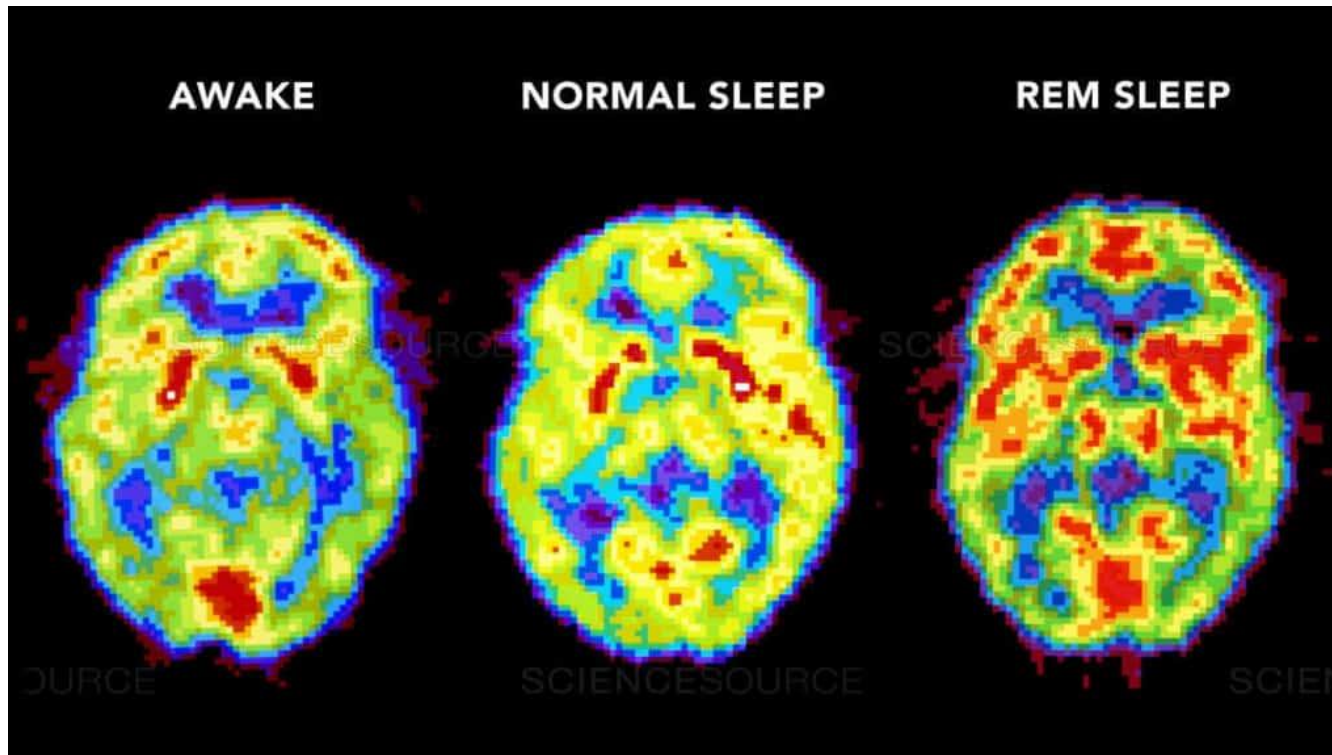
What can be measured are what are called "correlates" of consciousness?

Brain activities or activity patterns that occur when consciousness is present compared to the brain activity when consciousness is lost, such as during coma or sleep.



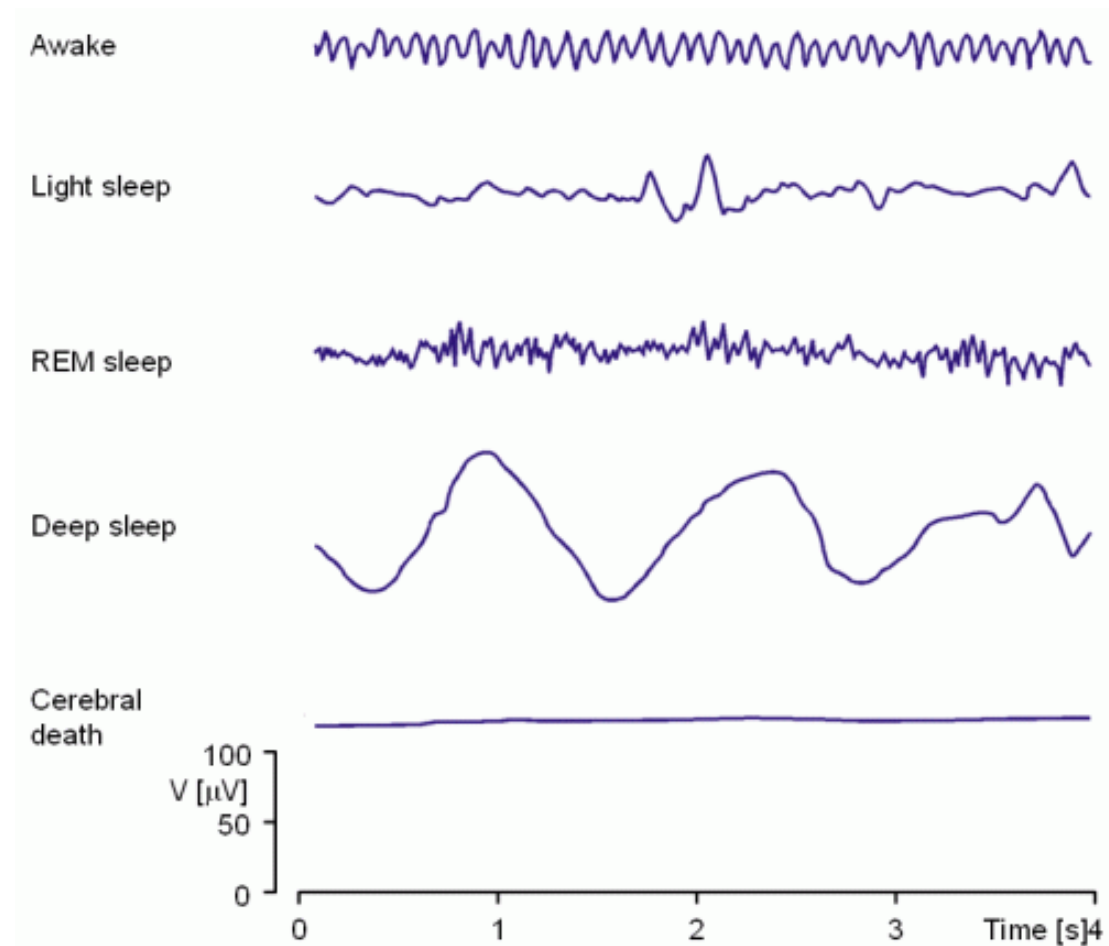
Consciousness

Neural activity in the brain, such as differences between highly conscious states like normal wakefulness versus sleep or coma, and alterations in consciousness resulting from brain damage.



Consciousness

Using electroencephalography (EEG) examination



Consciousness

If consciousness is defined as an introspective, linguistic-based, inner thought stream that exists only in humans but not in any other animal - then it can only be studied in humans.



Consciousness

Neuroscientists and philosophers do not all agree with the materialistic idea that consciousness is created by brain activity.

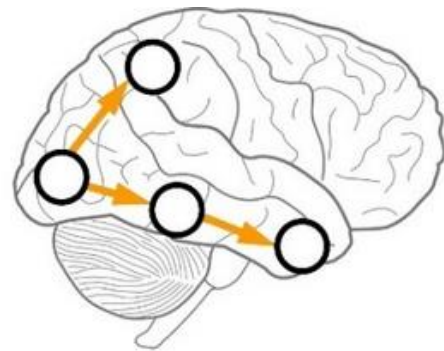
Alternative explanations for consciousness range from quantum mechanics to dualistic religious traditions that hold that a nonmaterial soul is the real seat of conscious.



Consciousness

Aspects of consciousness that we understand depend on neural activity in the brain, such as differences between highly conscious states like normal wakefulness versus sleep or coma, and alterations in consciousness resulting from brain damage.

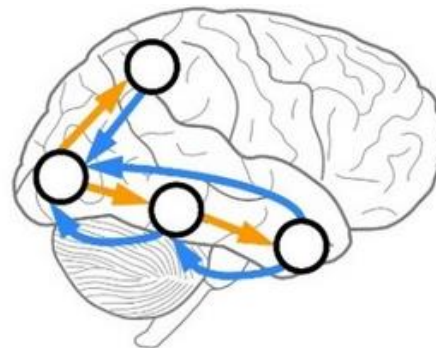
Although consciousness and high general intelligence clearly are associated with the neocortex, the existence of these mental abilities clearly still depends on lower brain structures such as the brainstem and thalamus, whose function is necessary but not sufficient for consciousness.



Feed-forward only



No conscious percept



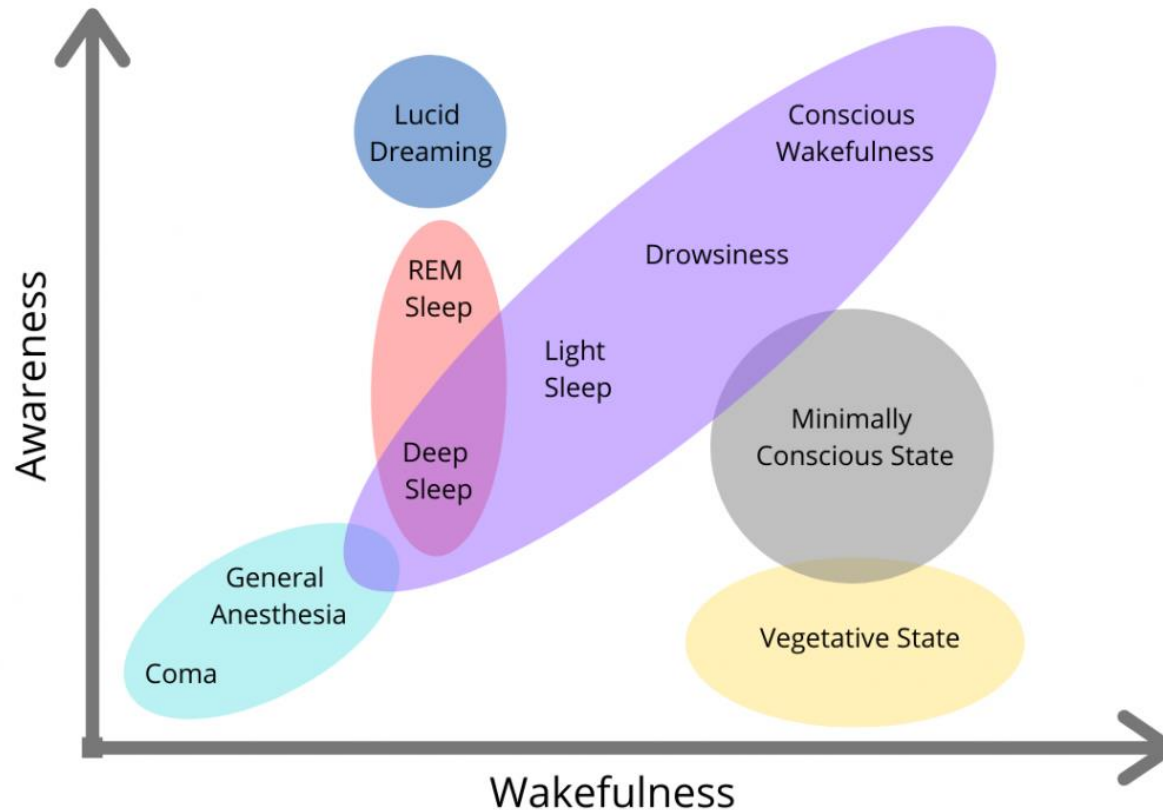
Feed-forward & **Feedback**



Conscious percept

Consciousness

We define (for vertebrates, at least) awareness as the brain state that permits active movement and response to the environment (as opposed to sleep) and consciousness as a state of awareness possessed only by humans, then the reticular formation is necessary for awareness, which itself is necessary, but not sufficient, for consciousness.



Consciousness

Before my teacher came to me, I did not know that I am.

I lived in a world that was a no-world.

I cannot hope to describe adequately that unconscious, yet conscious time of nothingness.

I did not know that I knew aught, or that I lived or acted or desired.

I had neither will nor intellect.

I was carried along to objects and acts by a certain blind natural impetus.

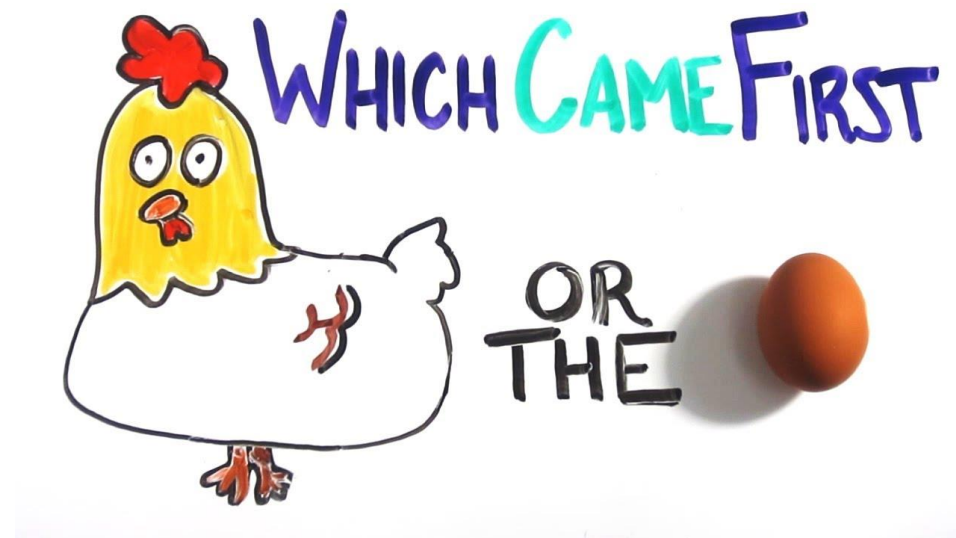
I had a mind which caused me to feel anger, satisfaction, desire.

Helen Keller, 1903



Consciousness

Consciousness is highly impaired without language, which all typically developing humans acquire purely by exposure with little explicit instruction.



One thing that language might contribute to consciousness is the ability to have episodic memory.

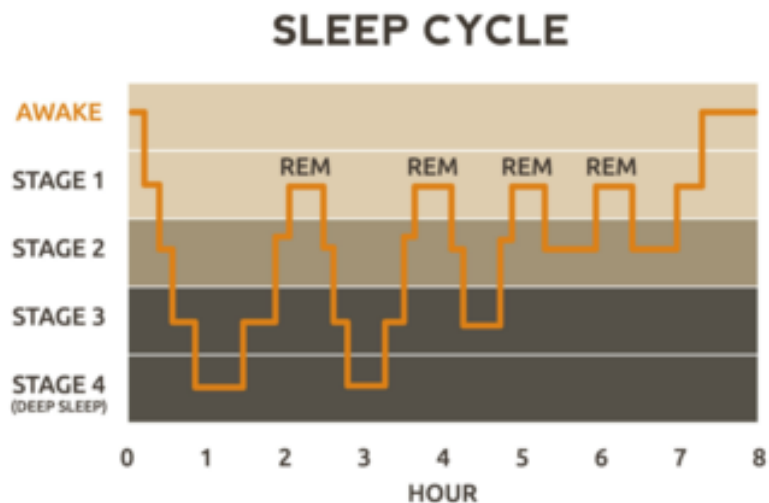
Consciousness

Sleep is the daily transition between consciousness and unconsciousness that virtually all humans experience daily.

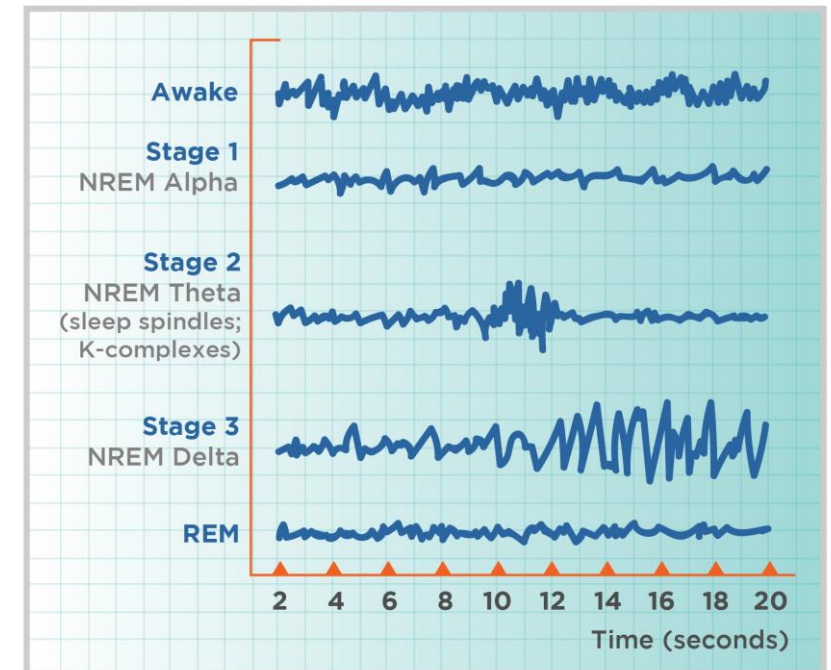
Sleep itself is complex, composed of rapid eye movement (REM) and non-REM categories.

Non-REM sleep is further divided into 4 different stages that differ in electroencephalogram (EEG) brain waves and physiologic attributes such as muscle tone.

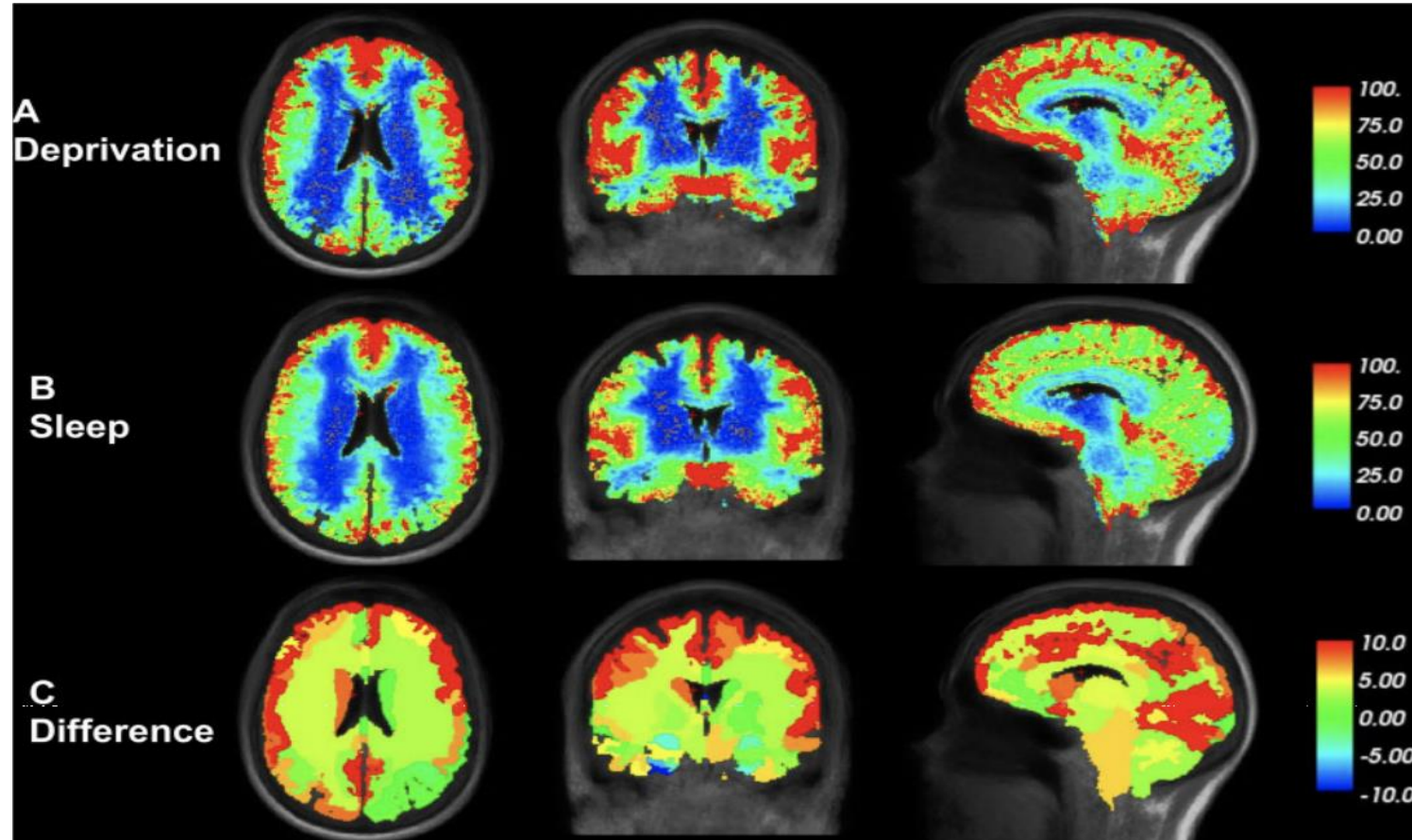
Most dreams occur during REM sleep



EEG RECORDINGS DURING SLEEP



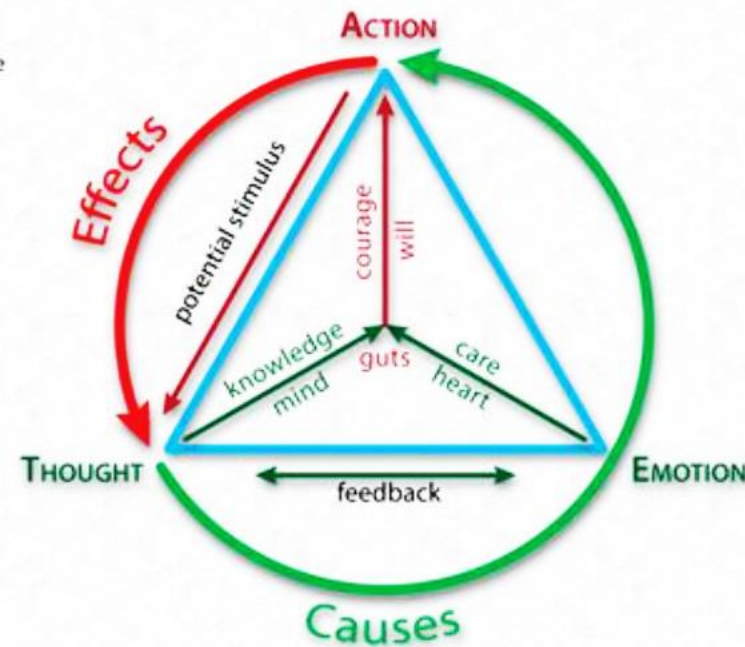
Sleep



Sleep and sleep cycles are controlled by the brainstem reticular formation (particularly the pons parabrachial area), several nuclei in the basal forebrain, and the hypothalamus, via the neurotransmitters acetylcholine (ACh), norepinephrine, and serotonin.

Consciousness and free will

Choices people make are caused not only by the hardware of their brain, but also by the hardware configuration modified by education, experience, knowledge of law and societal norms, and anticipated future consequences. Although the brain is a machine that operates on principles of chemistry and physics, the existence of ethics depends on the assumption that choices can be and should be made at the level of conscious knowledge.



Most neuroscientists would say that the phrase "free will" is a construct that is useful for explaining and predicting behavior.

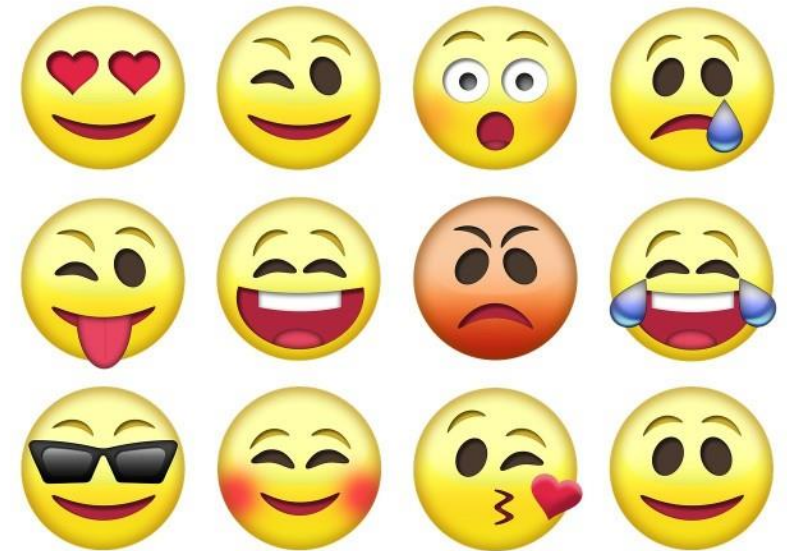


Emotion

A subjective state of mind. Emotions can be reactions to internal stimuli (such as thoughts or memories) or events that occur in our environment.

Emotions are not the same thing as moods. A mood is a state of mind that predisposes us to react a certain way. For example, someone in a low mood is more likely to feel irritated when they trip on a rock. Someone in a good mood is more likely to feel amused by the incident. In general, emotions are reactions to an event, while moods are present before and throughout the event.

Emotions by themselves are neither good nor bad. They are simply reactions. However, the way we act (or don't act) on our emotions can strongly affect our well-being.



Emotions

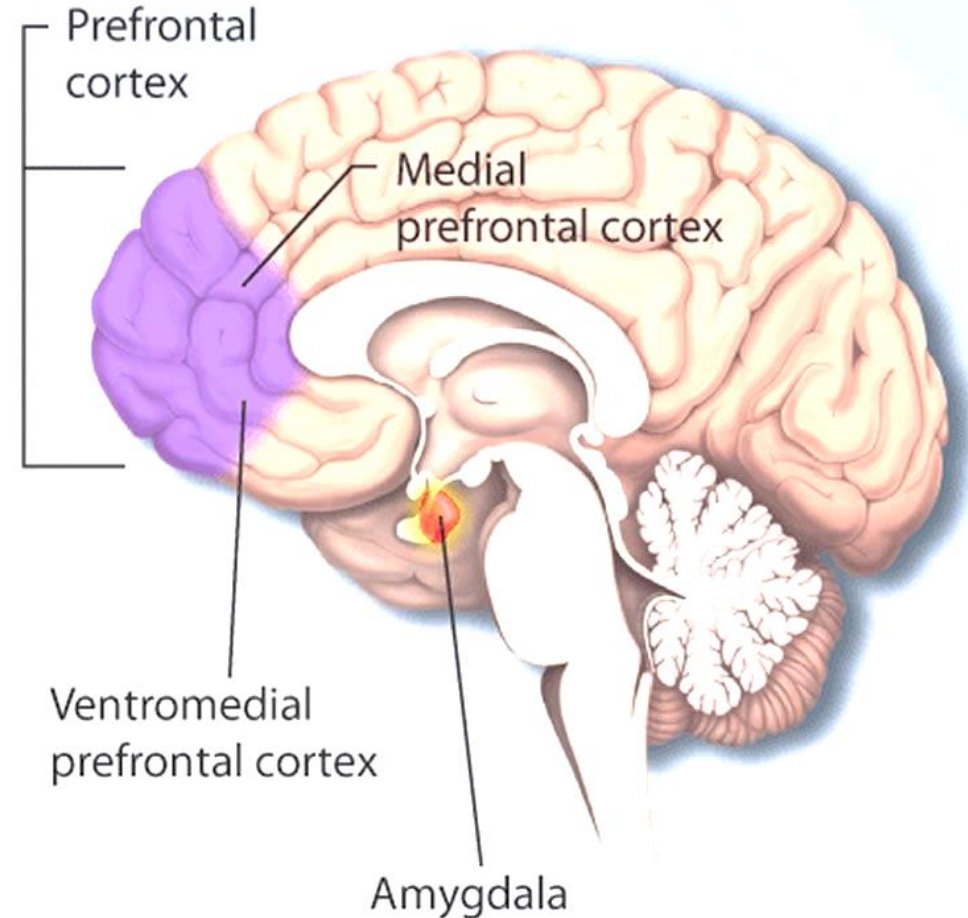
Feelings generated by basic instincts and drives and by the assessment of progress or frustration of those drives.

Emotions depend on the limbic system.

The limbic system in turn, interacts with the autonomic nervous system to control whether the body should be in the sympathetic fight/flight body state or oriented toward homeostasis.

The limbic system also interacts with sensory organs that assess the state of the environment and with the neocortex, which modulates behavior based on contextual memories.

A particularly important part of the brain related to emotion and limbic function is the amygdala-ventromedial frontal lobe system that is responsible for assessing emotionally salient risks, such as those associated with living in social groups.



Defining emotions

Basic instincts and drives make their presence felt by generating emotions that motivate the organism toward some action.

Emotional drive is both generated by and produced from the state of the autonomic nervous system. Typically are based on immediate survival needs such as thirst, hunger, reproductive activity and social rank maintenance.

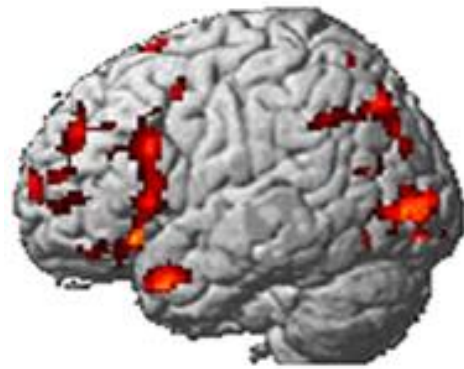
The behaviors triggered by external sensory input often depend on learned associations from previous experience.



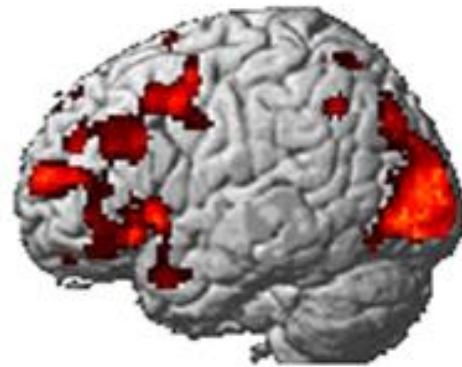
Emotions

Associated with body states mediated by different relative levels of sympathetic versus parasympathetic neurotransmitters as well as other neurotransmitters and neuromodulators.

Emotional responses are processed initially at limbic brain levels and the autonomic nervous system, with cognitive responses occurring later along a slower pathway involving higher brain areas.



HAPPY



SAD

Emotional response

what are other
words for
emotional response?



sensibility, responsiveness,
deep feeling, receptivity,
susceptibility, feeling,
awareness, affection, emotion



Expression of emotions



Social mammals communicate more complex emotional repertoires than nonsocial mammals or nonmammalian vertebrates.

Darwin in his book „The Expression of the Emotions in Man and Animals”, argued that emotional communication is selected for because it aids survival in social groups.

Anger



Fear



Disgust



Happiness



Sadness



Surprise



Neutral



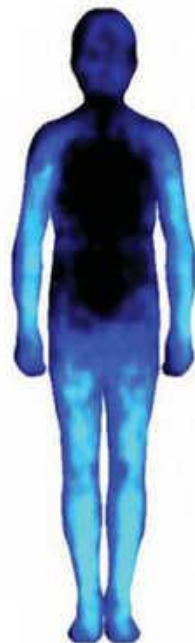
Anxiety



Love



Depression



Contempt



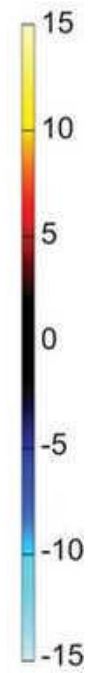
Pride



Shame



Envy



Expression of emotions

The limbic system processes and integrates sensory information from internal sensors of body state such as blood pressure, sugar level, and temperature with external sensory input from smell, vision, audition, taste, and skin senses.

In its interaction with the ventromedial prefrontal cortex the limbic system evaluates this sensory input in light of learned associations from experience.

Consists of

- portions of frontal lobe
- portions of temporal lobe
- hypothalamus
- thalamus
- basal nuclei
- other deep nuclei
- associated with sense of smell (less significant)

Functions

- controls emotions
- produces feelings
- interprets sensory impulses
- facilitates memory storage and retrieval (learning!)

The motivational system

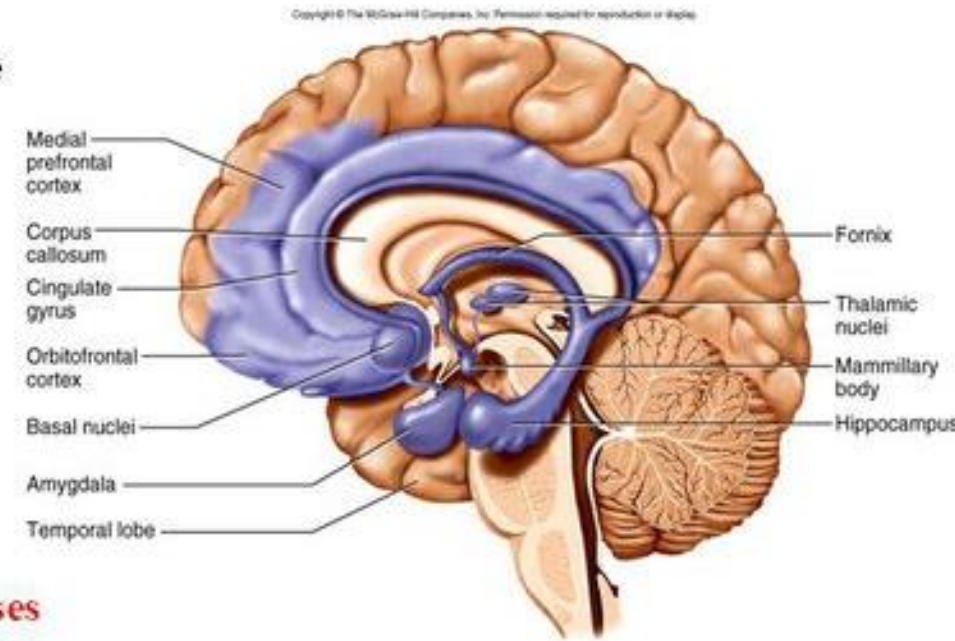


Figure from: Saladin,
Anatomy & Physiology,
McGraw Hill, 2007

Emotions

The product of a complex neural processing system that is experience and case based, rather than rule based.

Emotions are the „language” by which the limbic and autonomic nervous systems communicate with the rest of the brain.



The autonomic, limbic, ventromedial prefrontal system acts rapidly before complex conscious processing and awareness, as is necessary for survival. Some aspect of how the car in front of you is being driven causes you to back away without your being aware of doing so or being able to say why, but it saves your life.

"gut feelings"

Compared to conscious, verbal language used by other parts of the brain does not mean that the calculations done by this system are primitive and low dimensional.



Intrapersonal Communication



Interpersonal Communication



Small Group Communication



Public Communication

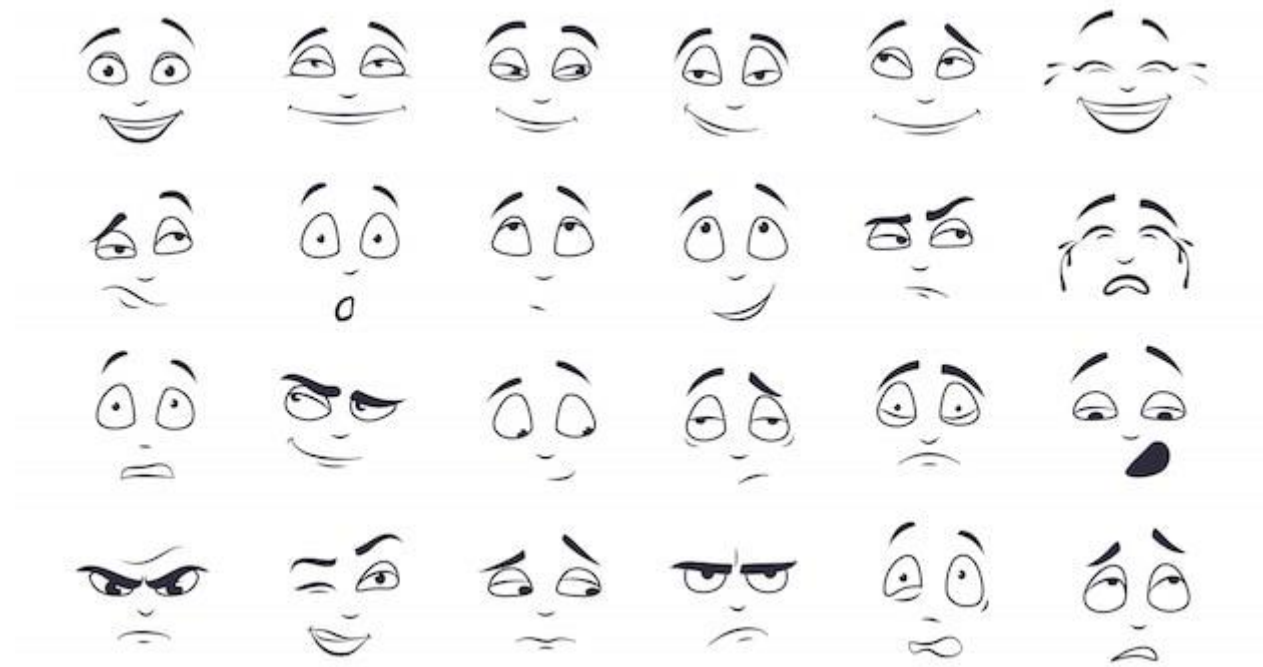


Mass Communication

The guidance given by emotion for appropriate behavior in complex social situations may be based on complex, unconsciously processed cues and nondeclarative memories, including body language, tone of voice, facial expressions, and previous experiences with these elements.

Emotional intelligence

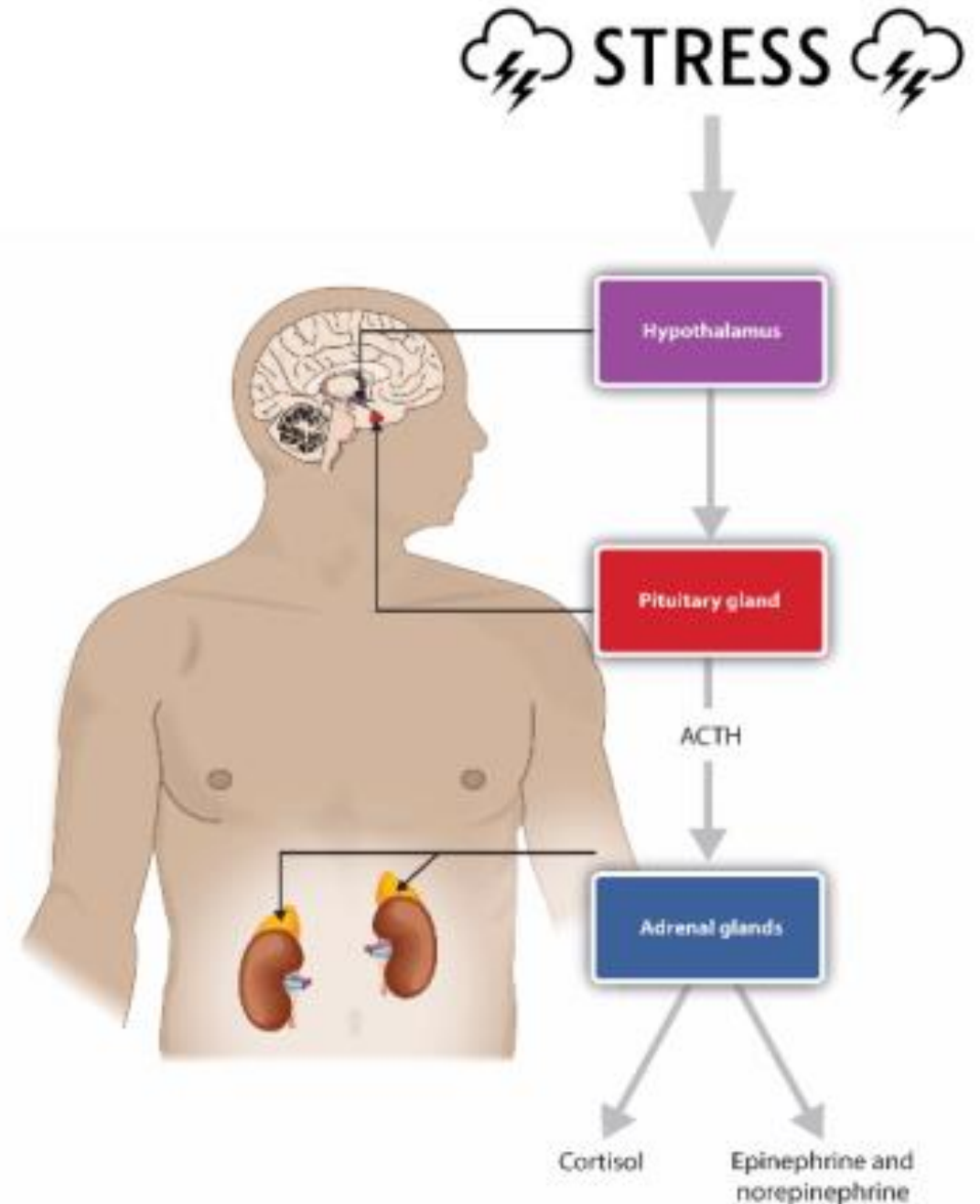
We are constantly unconsciously processing facial expressions, body postures, and tones of voice of those around us.



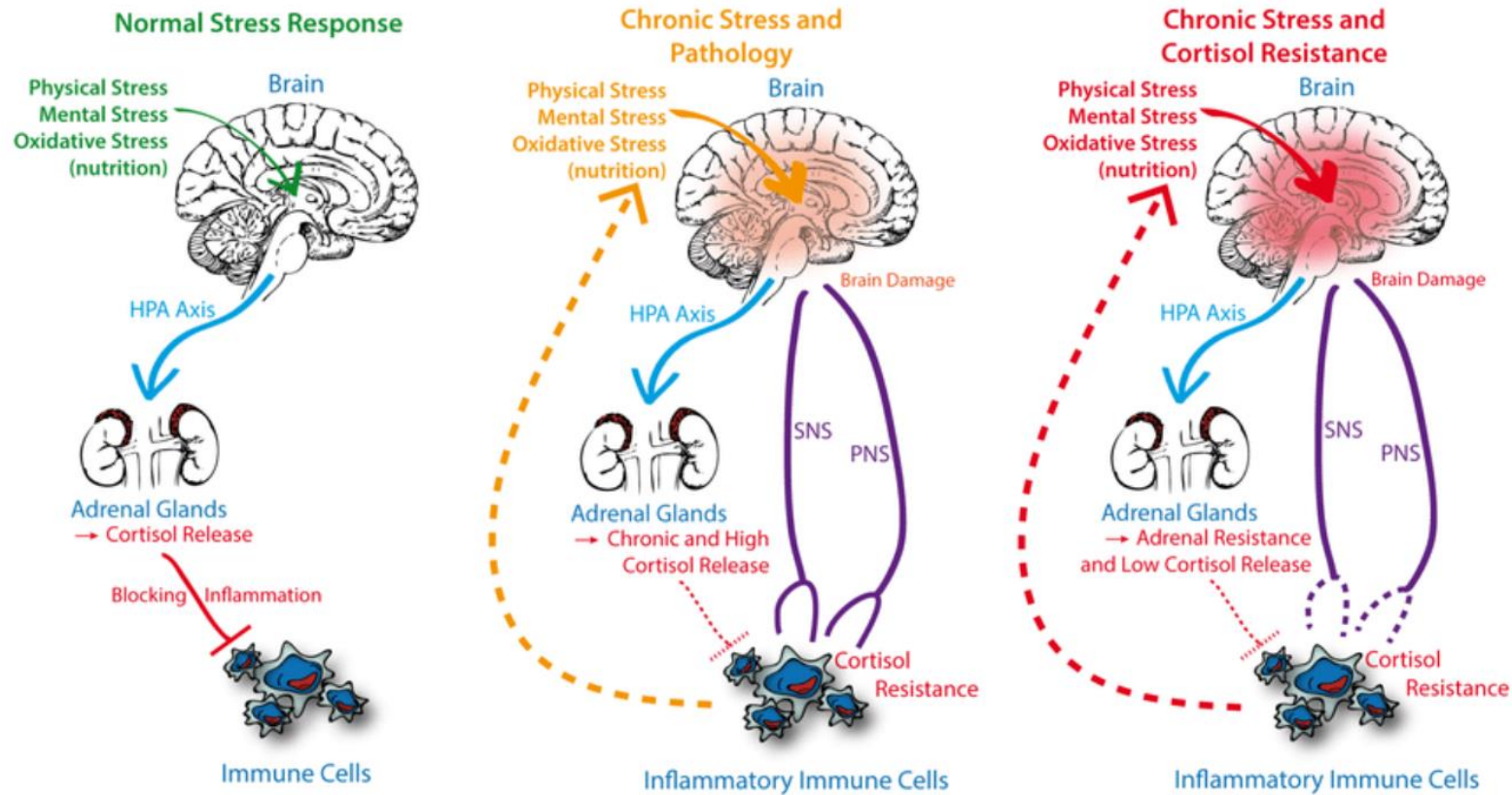
Autonomic Responses - LeDoux's term for the output of the amygdala-ventromedial system is somatic markers, what we usually call ,gut feelings,

These have a strong autonomic component, often switching the body from homeostasis (parasympathetic) to fight/flight sympathetic activation.

Sympathetic activation increases activity in the hypothalamus-pituitary-adrenal (HPA) axis, leading to internal changes such as increased heart rate, sweating, and pupil dilation.



Stress hormone



Cortisol levels increase during stress, which acts as a negative feedback, signal to reduce adrenal activation.

However, chronic stress associated with continuously elevated cortisol levels that is not effective in reducing sympathetic activation has negative effects on the body, such as as impairment of immune function, heart disease, and impairment of learning and memory.

Sociopathy

A unifying scheme for defining psychopathy is that it is characterized by a lack of ,gut feelings, of remorse or empathy. It may occur in individuals who are often otherwise above average in intelligence. Overlapping sociopathic traits include lack of emotional attachment and manipulativenness.



Sociopath	Psychopath
Impulsive and erratic	Calculative, thoughtful, and scheming
Can have deeper relationships with few closely connected people	All relationships are shallow
Unkind but has little empathy left in them	No empathy at all. Appears shrewd and heartless
Hot headed types	Cold hearted types
Poor self control	Highly controlled
Aggressive and impulsive in times of distress	Remains calm, composed, and thoughtful in times of distress
Tends to rationalize their wrong actions	They never rationalize their wrong actions.

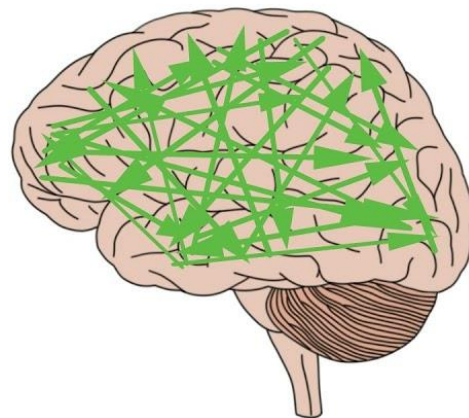
Damage to the amygdala-ventromedial system produces such traits, it seems highly likely that unknown damage to this system underlies most sociopathic behavior. Such damage may be organic, from, for example a tumor or head blow, or possibly secondary to environmental effects such as child abuse.

Autism

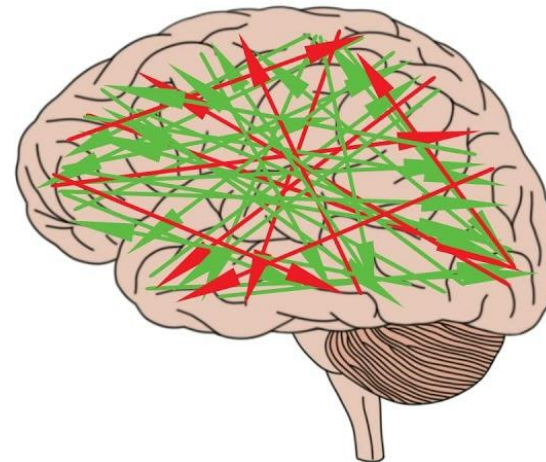
Spectrum disorder, probably originating from mutations at more than 10 gene loci and arising from multiple other causes. It ranges in severity from extremely mild (the absent-minded college professor) to profound mental retardation.

Antisocial behavior that, although once was interpreted as maliciousness, is now seen as an inability to comprehend that others have feelings that can be hurt. Autistic people are thought to be socially withdrawn and inept because of an inability to act in a socially appropriate manner, due to an underlying perceptual deficit.

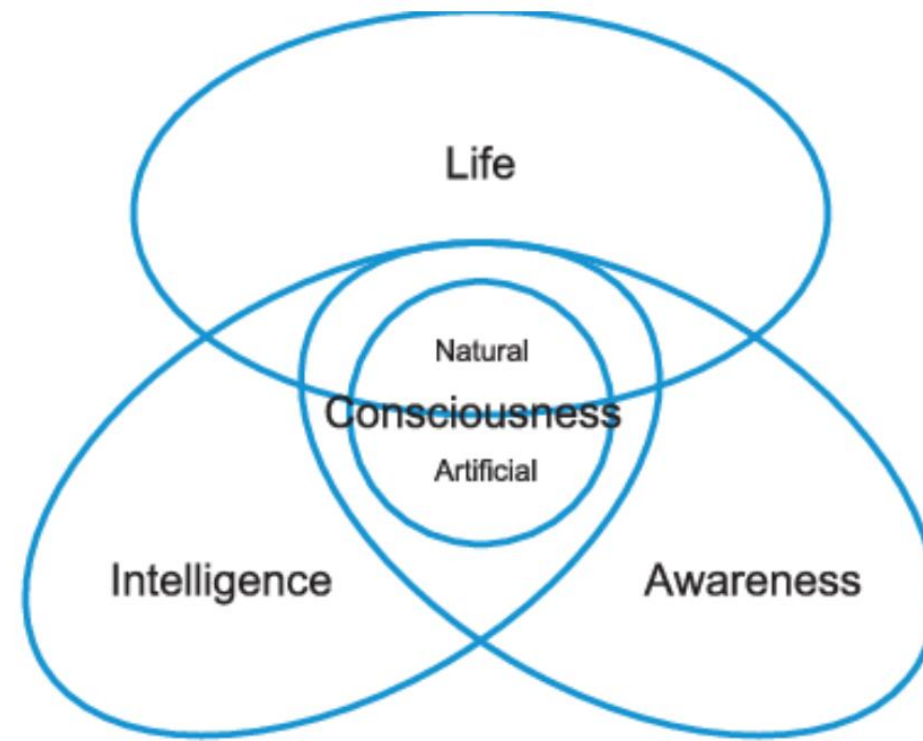
TYPICAL BRAIN



AUTISTIC BRAIN



- UNUSUALLY RAPID GROWTH
IN INFANCY AND EARLY CHILDHOOD
- ATYPICAL PATTERNS OF CONNECTIVITY



Understanding consciousness is one of the most fascinating challenges of our time.

From ancient civilizations to modern philosophers, questions have been asked on how one is conscious of his/her own existence and about the world that surrounds him/her.

Although there is no precise definition for consciousness, there is an agreement that it is strongly related to human cognitive processes such as attention, a process capable of promoting a selection of a few stimuli from a huge amount of information that reaches us constantly.

Brain tales



Thank you