

**Volgograd State Medical University  
Department of Normal Physiology**



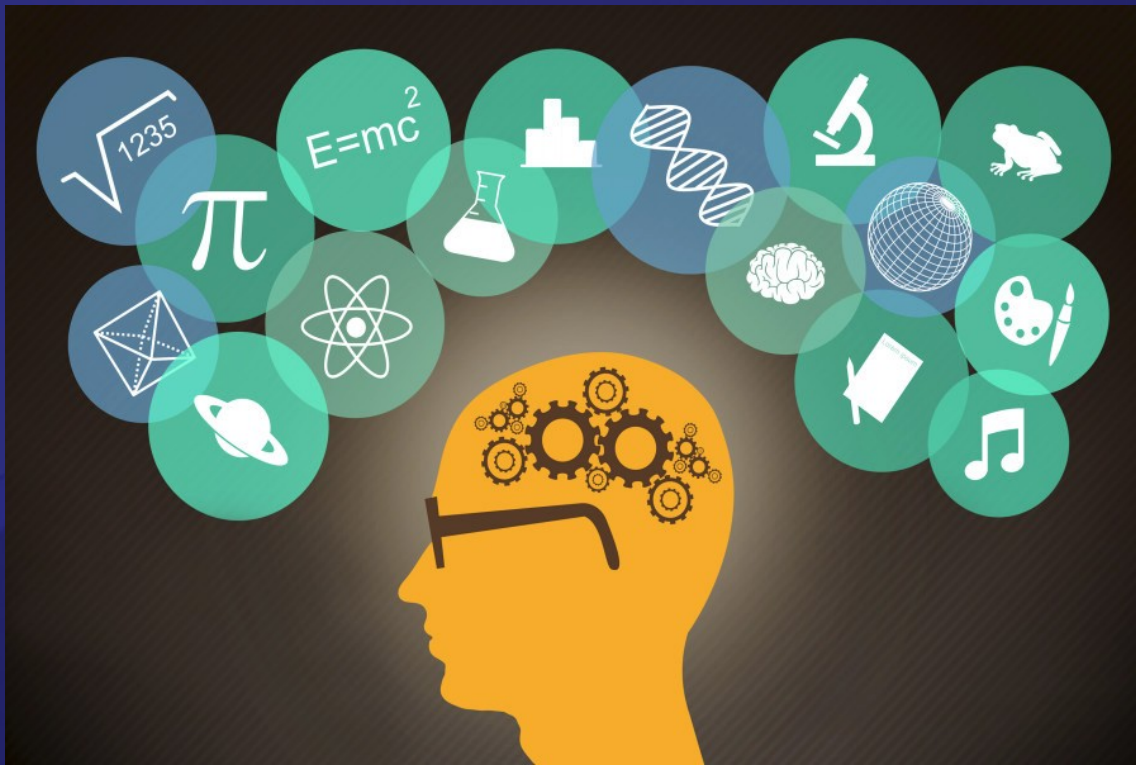
**Mechanisms of  
purposeful  
behavior (part 2)**

**K.V. Gavrikov, E.V. Lifanova,  
L.B. Osadshaya, Kudrin R.A.**

# Plan

1. Memory. Types of memory.
2. Understanding the mechanisms of short-term and long-term memory.
3. Doctrine of I. P. Pavlov about types of higher nervous activity.
4. Role of upbringing in the formation of the typological properties of HNA.
5. Features of human HNA.
6. Doctrine of I. P. Pavlov about I and II signaling systems.

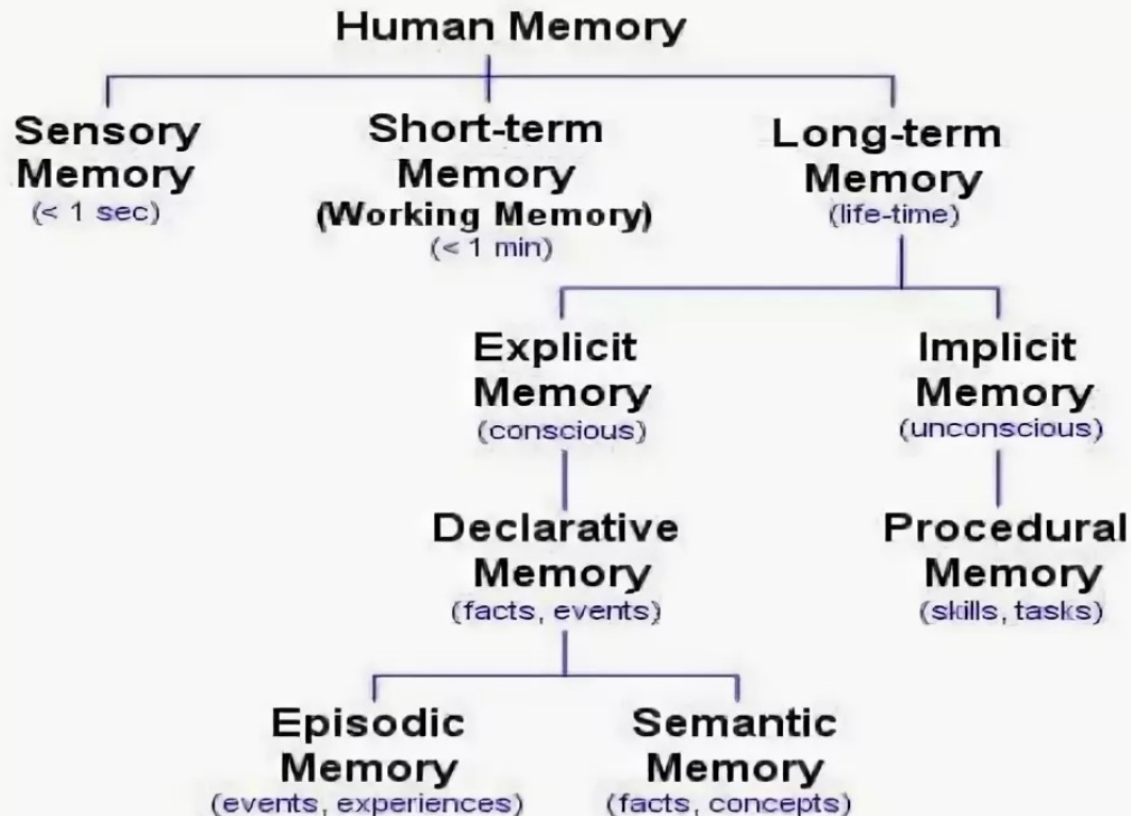
# 1. Memory. Types of memory



**Memory** — structure and processes involved in the encoding, storage, and retrieval of information, including both procedural and declarative information.

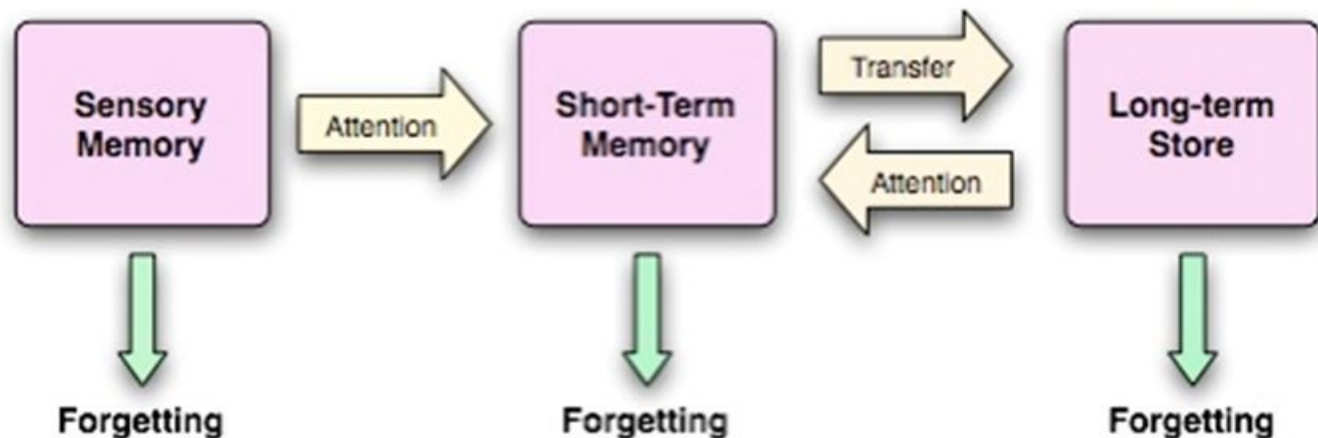


# Types of memory diagram

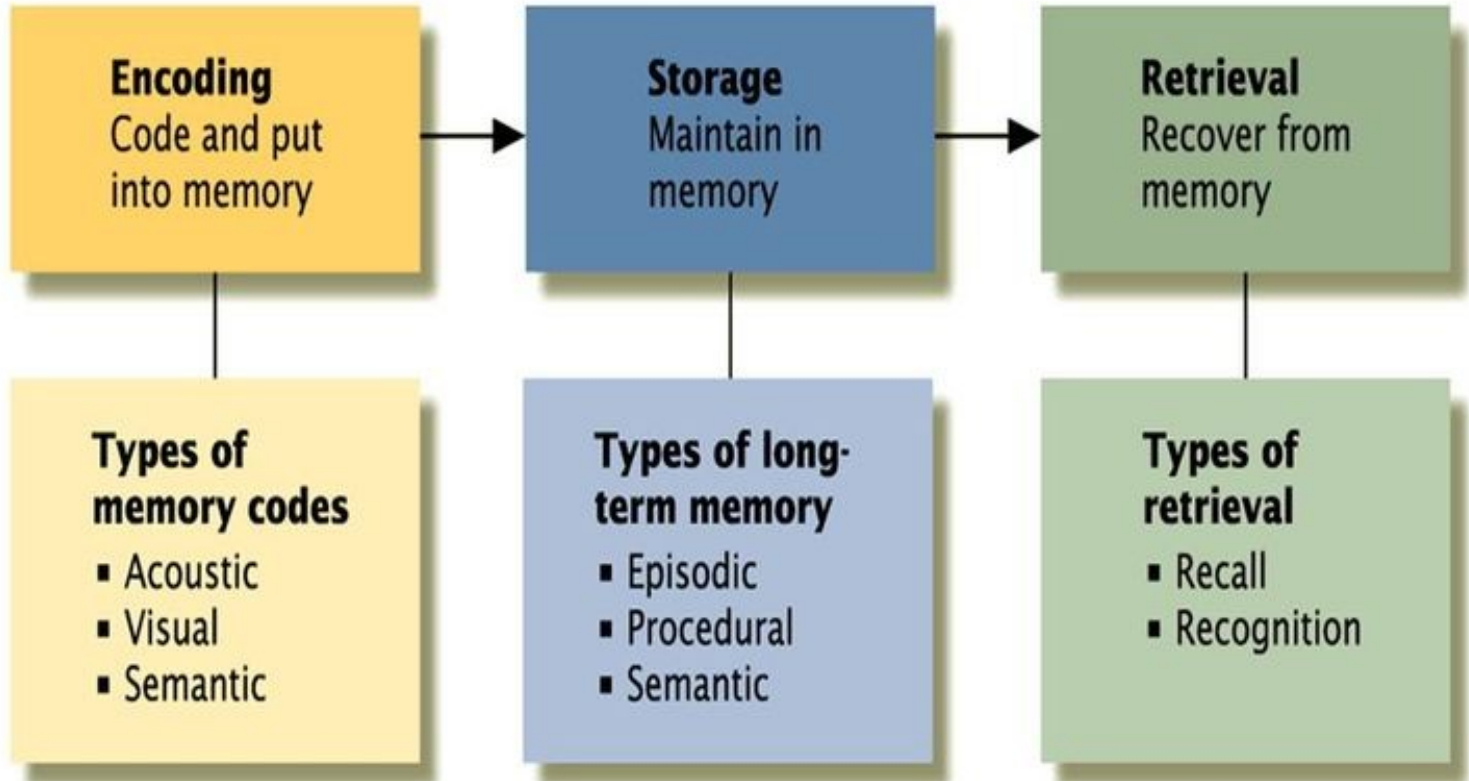


# Types of memory

- **Atkinson-Shiffrin's multi store model of memory** describes three levels of memory.



# Basic Memory Processes



## **2. Understanding the mechanisms of short-term and long-term memory**



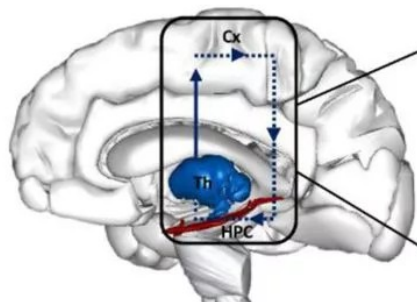


▲ TABLE 5-3

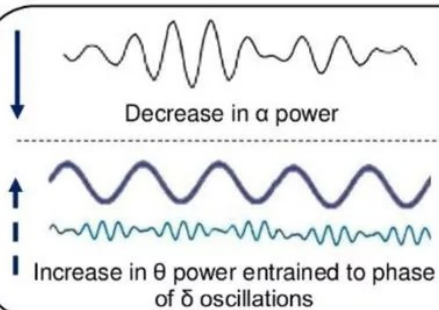
## Comparison of Short-Term and Long-Term Memory

Characteristic	Short-Term Memory	Long-Term Memory
<b>Time of Storage after Acquisition of New Information</b>	Immediate	Later; must be transferred from short-term to long-term memory through consolidation; enhanced by practice or recycling of information through short-term mode
<b>Duration</b>	Lasts for seconds to hours	Retained for days to years
<b>Capacity of Storage</b>	Limited	Very large
<b>Retrieval Time (remembering)</b>	Rapid retrieval	Slower retrieval, except for thoroughly ingrained memories, which are rapidly retrieved
<b>Inability to Retrieve (forgetting)</b>	Permanently forgotten; memory fades quickly unless consolidated into long-term memory	Usually only transiently unable to access; relatively stable memory trace
<b>Mechanism of Storage</b>	Involves transient modifications in functions of preexisting synapses, such as altering amount of neurotransmitter released	Involves relatively permanent functional or structural changes between existing neurons, such as formation of new synapses; synthesis of new proteins plays a key role

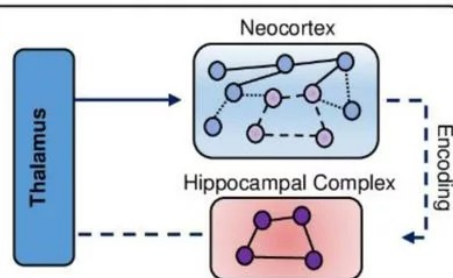
### (A) Wakeful Memory Encoding



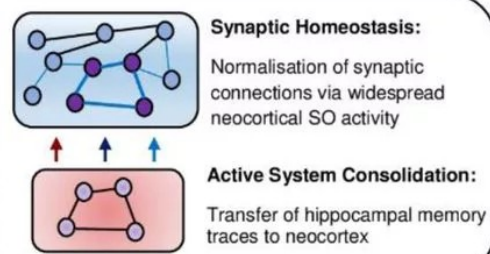
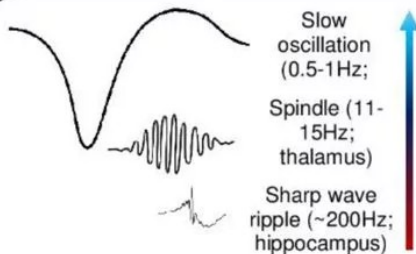
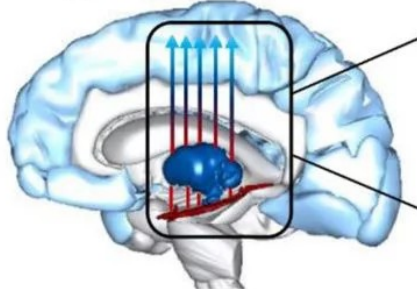
### Oscillatory Mechanisms



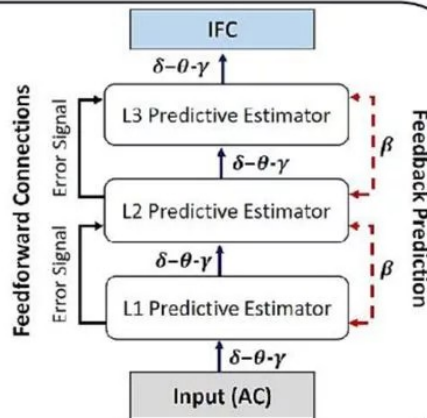
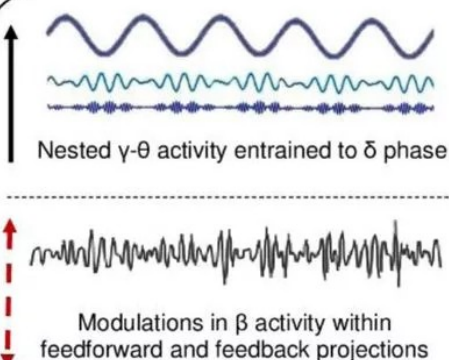
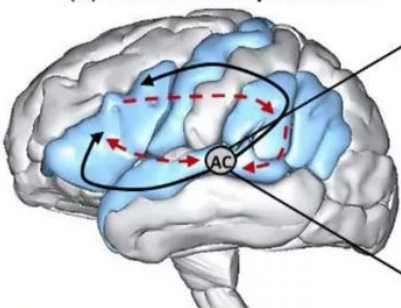
### System-Level Changes



### (B) Sleep-Dependent Consolidation



### (C) Sentence Comprehension

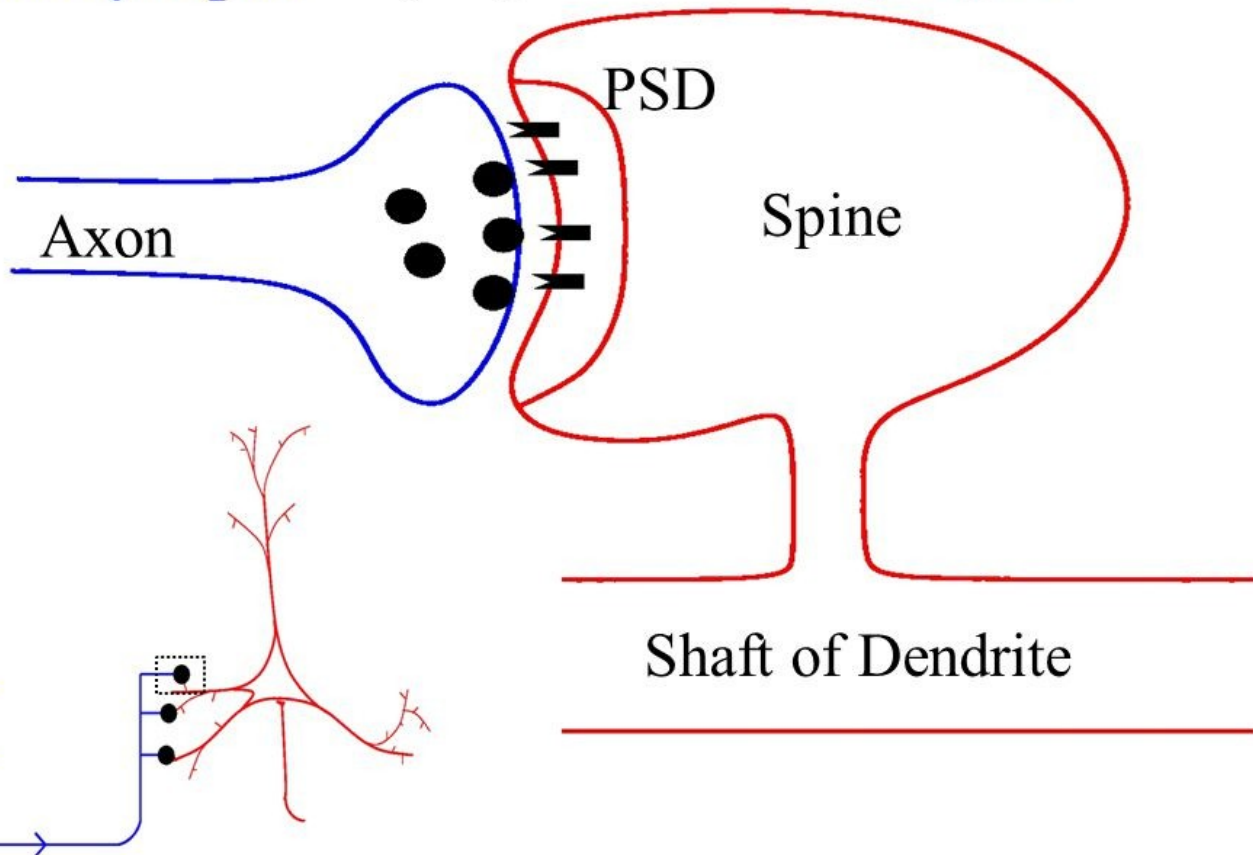


# Molecular mechanisms of long-term memory

**Presynaptic**

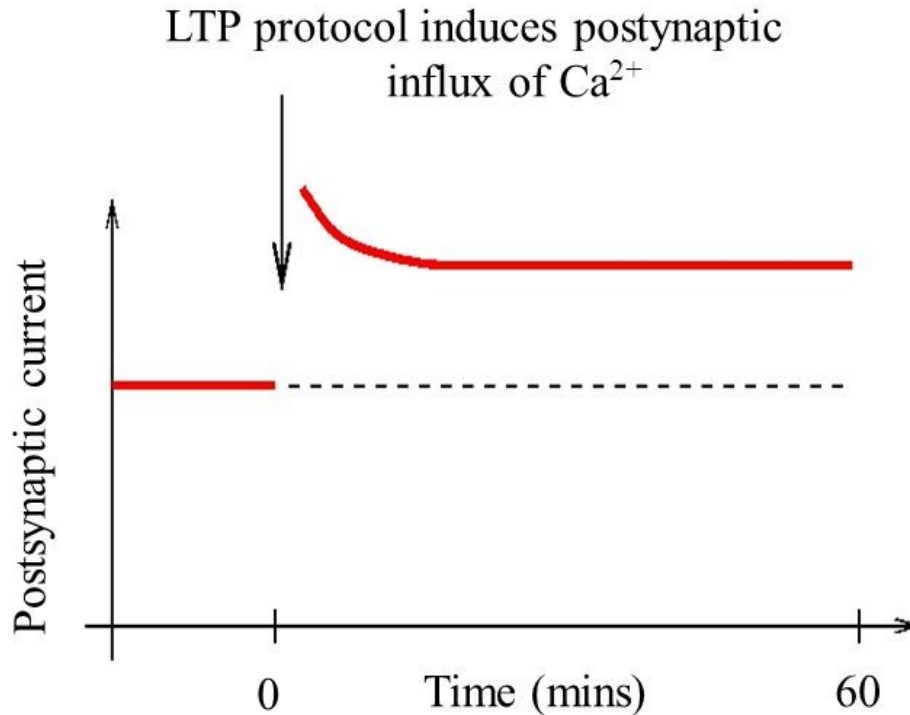
**Synapse**

**Postsynaptic**



# LTP: an increase in synaptic strength

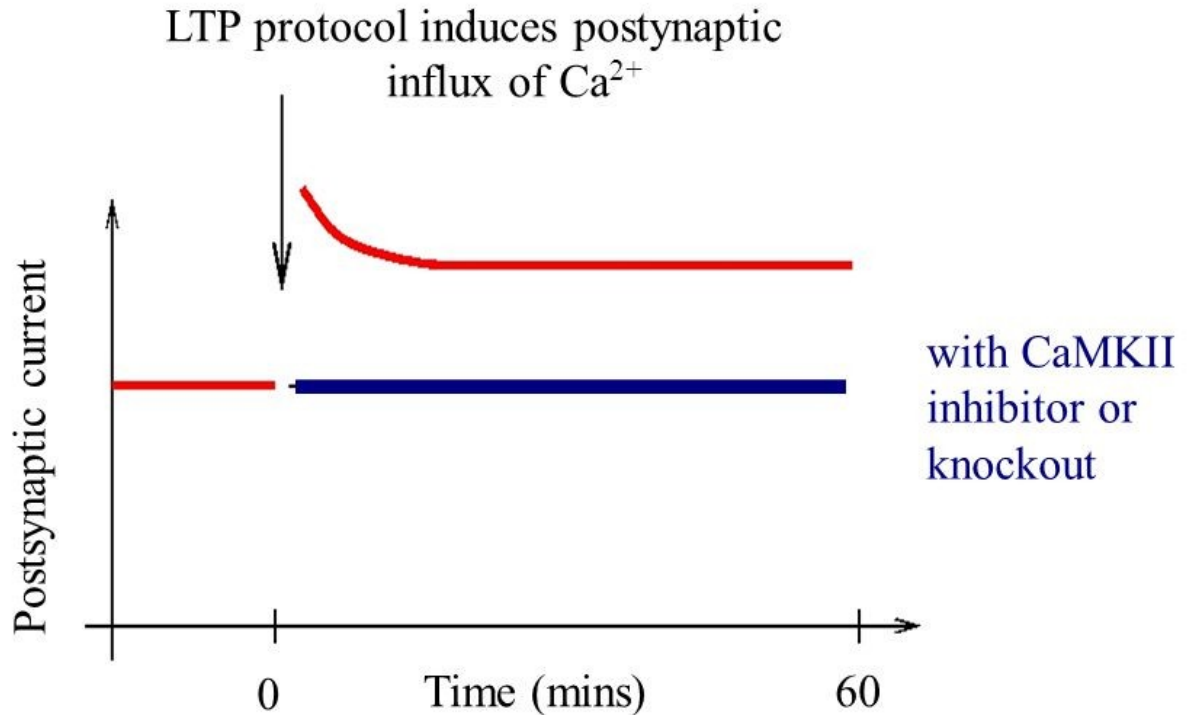
## Long-term potentiation (LTP)



Bliss and Lomo J Physiol, 1973

# LTP: an increase in synaptic strength

## Long-term potentiation (LTP)



Lledo et al PNAS 1995, Giese et al Science 1998

# 3. Doctrine of I.P. Pavlov's about types of higher nervous activity (HNA)

lumie  
TEMPERAMENT EDITION



**CHOLERIC**

THE POWERFUL LEADER

FLUORESCENT

• 10 COLORED PENCILS •

lumie  
TEMPERAMENT EDITION



**SANGUINE**

THE POPULAR ENTERTAINER

PRIMARY

• 10 COLORED PENCILS •

lumie  
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**PHLEGMATIC**

THE CALM PEACEKEEPER

PASTEL

• 10 COLORED PENCILS •

lumie  
TEMPERAMENT EDITION



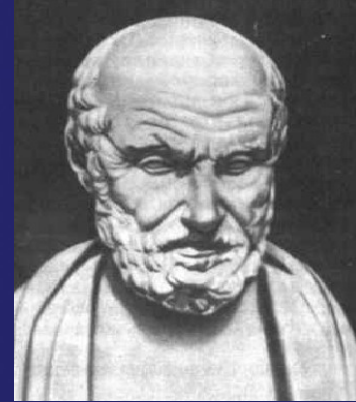
**MELANCHOLIC**

THE SENSITIVE PERFECTIONIST

TERTIARY

• 10 COLORED PENCILS •

# Features of human HNA

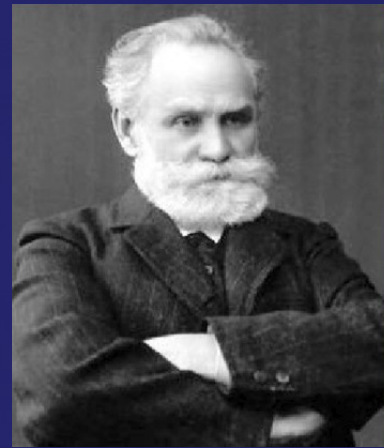


Even ancient doctors correctly drew attention to individual differences temperament of people, manifested not only in their character, actions, but also in their attitude to diseases, and they tried to understand the nature of this difference.

So, **Hippocrates**, based on the doctrine of the "juices of the body", believed that the predominance of:

- hot blood (sanguis) makes a person an energetic and determined **sanguine**;
- an excess of chilled mucus (phlegma) gives him the features of a cold-blooded and slow **phlegmatic**;
- acrid bile (chole) causes hot temper and irritability of the **choleric**;
- black spoiled bile (melan chole) determines the behavior of a sluggish and dull **melancholic**.

# Types of HNA by I.P. Pavlov



The true nature of temperaments has been revealed in the light of the teachings of **I.P. Pavlov** about the highest nervous activity, which, by studying features of the formation of conditioned reflexes in animals, drew attention to the fact that the rate of their formation, strength, development of differentiation in different dogs are different.

This gave rise to the division of animals into several types, depending on the individual properties of their nervous system.

The **type of HNA** is understood as a set of properties of nervous processes caused by hereditary characteristics of the organism and acquired in the process of its individual life.



# Types of HNA by I. P. Pavlov

The separation into **types of higher nervous activity** is based on the properties of nervous processes — *excitation* and *inhibition*:

- force;
- balance;
- mobility.

The **force** of nervous processes is understood as the ability of the cells of the cerebral cortex to maintain adequate responses to strong and superstrong stimuli.

For example, if a conditioned reflex to strong stimulation is developed and a state of inhibition does not occur, then the nerve cells of the cortex are highly efficient.

# Types of HNA by I.P. Pavlov

**Balance** is understood to mean the same intensity of excitation and inhibition processes.

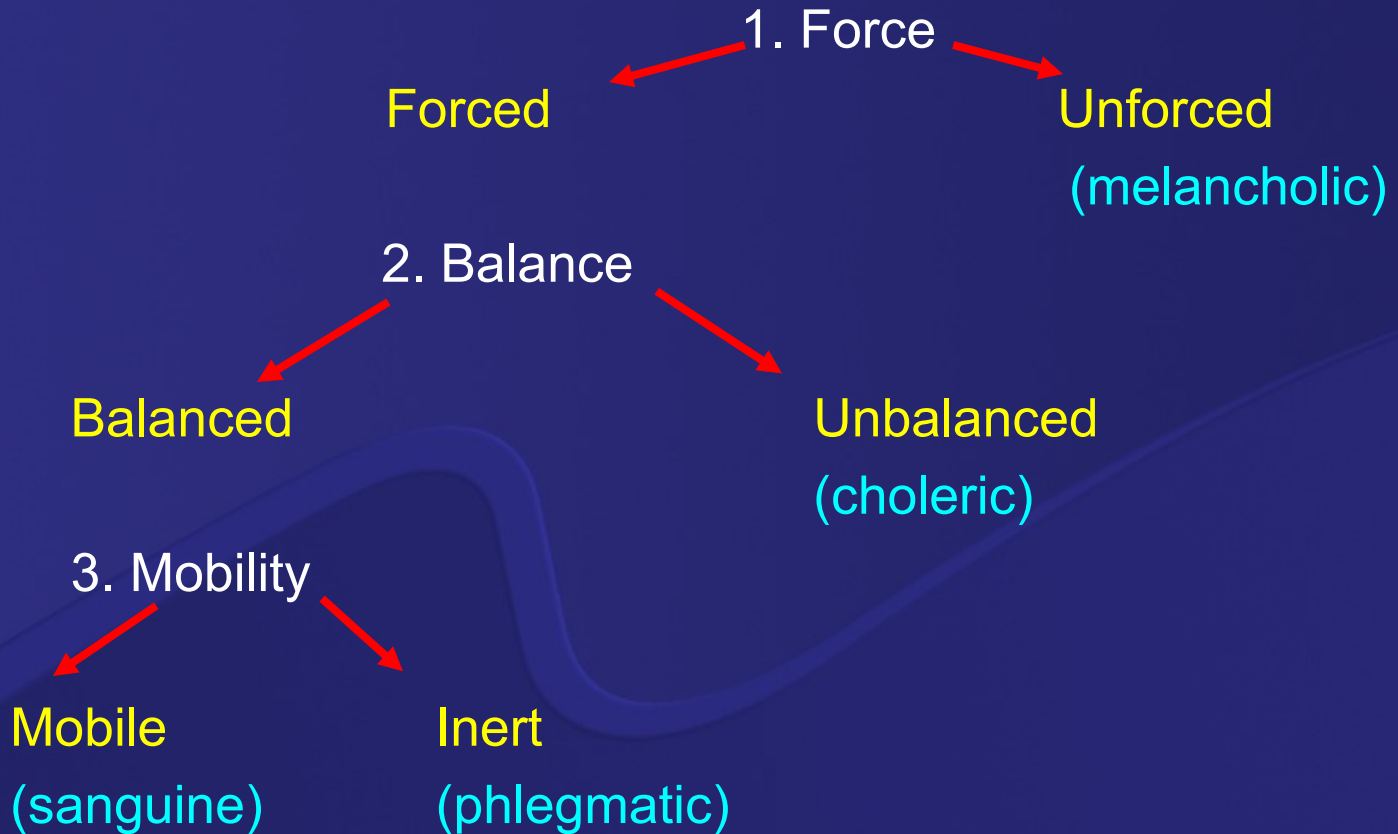
Nervous processes can be balanced or one of them can prevail over the other (more often excitement).

The **mobility** of nervous processes characterizes the rapidity of the transition of the process of excitation into inhibition, and vice versa.

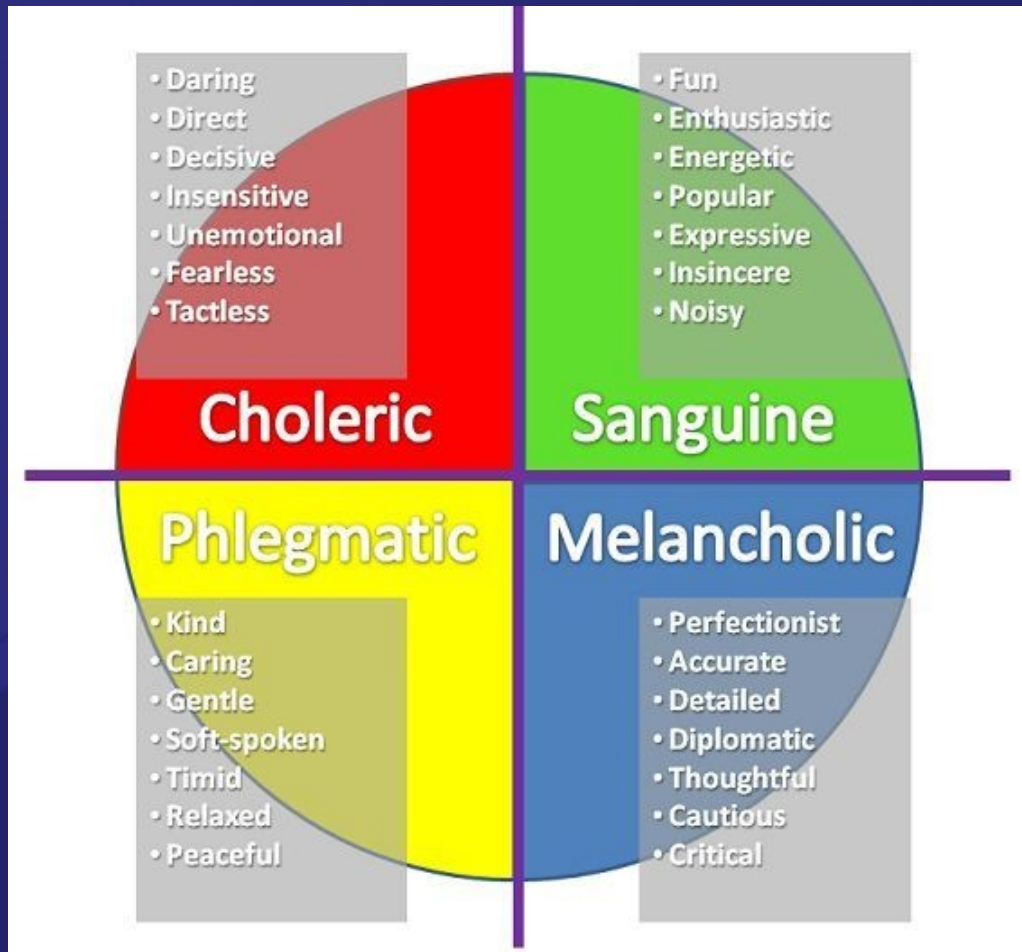
This property was determined by Pavlov according to the ability of animals to retrain.

Based on this, the main types of HNA were identified.

# Types of HNA by I.P. Pavlov



# Types of HNA by I.P. Pavlov



# Types of HNA by I.P. Pavlov

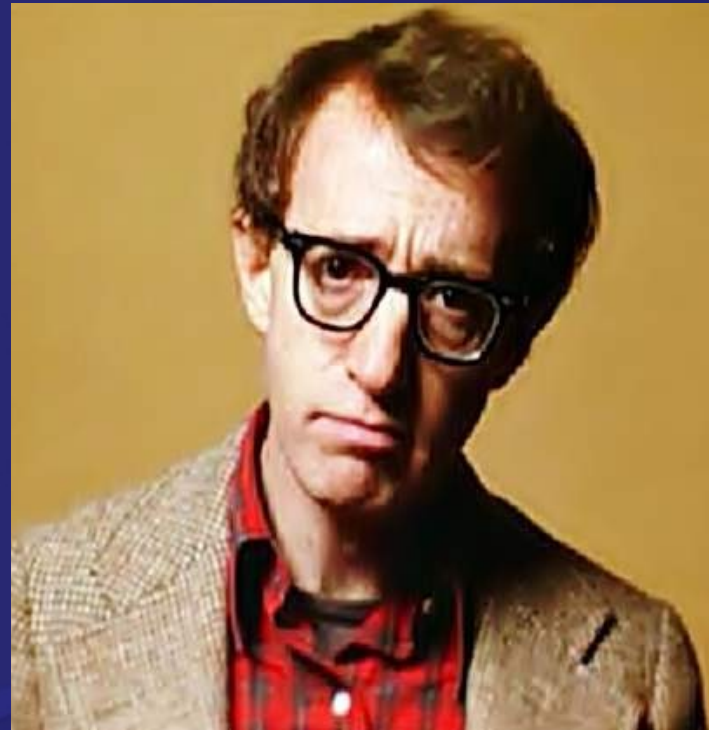
<i>choleric</i>		<i>sanguine</i>	
Strengths	Weakness	Strengths	Weakness
▷ Ambitious	▷ Demanding	▷ Sociable	▷ Impulsive
▷ Planner	▷ Intolerant	▷ Out-going	▷ Often Late
▷ Efficient	▷ Too Busy	▷ Optimistic	▷ Selfish
▷ Leader	▷ Impatient	▷ Forgives	▷ Exaggerates
▷ Confident	▷ Tense	▷ Confident	▷ Forgetful
▷ Motivator	▷ Inflexible	▷ Fun-Loving	▷ Shameless

<i>melancholic</i>		<i>phlegmatic</i>	
Strengths	Weakness	Strengths	Weakness
▷ Thoughtful	▷ Moody	▷ Calm	▷ Shy
▷ Considerate	▷ Discontent	▷ Reliable	▷ Passive
▷ Organized	▷ Obsessive	▷ Diplomatic	▷ Indecisive
▷ Detailed	▷ Perfectionist	▷ Content	▷ Permissive
▷ Creative	▷ Pessimist	▷ Accepting	▷ Unambitious
▷ Self-Reliant	▷ Tunnel Vision	▷ Rational	▷ Apathetic

# Types of HNA by I.P. Pavlov

- **Melancholic people** are characterized by low efficiency, fatigue, indecision, inability to overcome difficulties, to achieve goals. These people are easily suggested, show inadequate pessimistic reactions, and are prone to nervous breakdowns.



# Types of HNA by I.P. Pavlov

- **Sanguine** people are characterized by a balance between the processes of excitation and inhibition. These are people with a rapid development of conditioned reflexes and their rapid extinction.



# Types of HNA by I.P. Pavlov

- **Choleric** people are characterized by great force of nervous processes, where excitement prevails over inhibition. These are very excitable people with a high working capacity. Such people are very irritable, hurried. They don't hold back emotions. They have expressed motor restlessness.





# Types of HNA by I.P. Pavlov

- Calmness and good working capacity are characteristic of **phlegmatic** persons. However, they do not switch well to new types of activity, they do not get used to the new environment well, they are distinguished by inertness and tenacity of thinking, they remember grievances for a long time, and do not get along well with people.



# Types of temperaments (by Bidstrup, 1968)



ХОЛЕРИК

**Choleric**



ФЛЕГМАТИК

**Phlegmatic**



МЕЛАНХОЛИК

**Melancholic**



САНГВИНИК

**Sanguine**

## **4. Role of upbringing in the formation of typological properties of HNA**



# Role of upbringing in the formation of typological properties of HNA

Personality can be defined as a separately taken concrete person with inherent individual biological and socially determined properties and qualities of the psyche.

**Intelligence** is the most important characteristic of a person and is a complex mental phenomenon that **includes in its structure:**

- attention;
- memory;
- thinking.



# Role of upbringing in the formation of typological properties of HNA

**The condition for intellectual activity and its characteristics are mental abilities.** The development of abilities occurs throughout life.

**Intelligence** manifests itself in cognitive activity and includes acquired knowledge, experience and the ability to further use them in practice. **Speech** is of great importance, which plays an essential role in shaping and using concepts, acquired knowledge and experience.



# Role of upbringing in the formation of typological properties of HNA

Another important aspect of the personality is the **emotional-volitional sphere**. Emotionality is understood as a complex of characteristics that determine the dynamics of the emergence, course and termination of various emotional states.

Allocate general activity, which, along with emotionality, is included in temperament based on mobility and balance of excitation and inhibition processes.

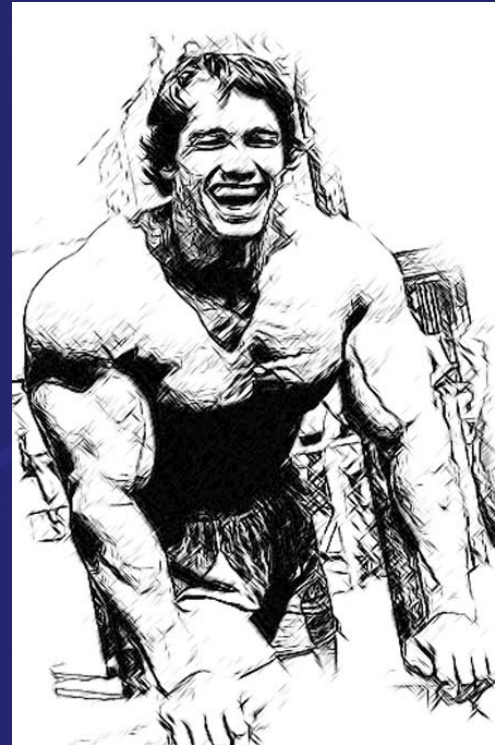


# Role of upbringing in the formation of typological properties of HNA

There is a close connection between temperament and character.

I.P. Pavlov on the prevalence of influence heredity or environment on the body defined temperament as genotype and character as a phenotype, emphasizing dependence character formation from external impacts in the process of individual personal development.

Separate character traits are mutually connected and form a holistic body organization — structure of character.



# Role of upbringing in the formation of typological properties of HNA

The character is laid down in childhood, but individual properties can change and be brought up throughout life, since the character properties are determined not by biological, hereditary laws, but by the social relations of the individual.

A study of homozygous twins with exactly the same hereditary characteristics showed that raised in different material and cultural level of conditions they found similar properties of temperament and various character traits.





# Role of upbringing in the formation of typological properties of HNA

The ability to regulate the formation of personality in the desired direction is achieved:

- training;
- exercise;
- training;
- education.

Moreover, in the formation of the psyche the leading role is played by education, realized through **learning**.



## 4. Features of human HNA



# Features of human HNA

**Mental processes** are closely related to **physical phenomena**, but not reducible to them.

Psychic phenomena are based not on elementary processes of excitation and inhibition, but on systemic processes that combine individual physiological manifestations into an integrated whole.



# Features of human HNA

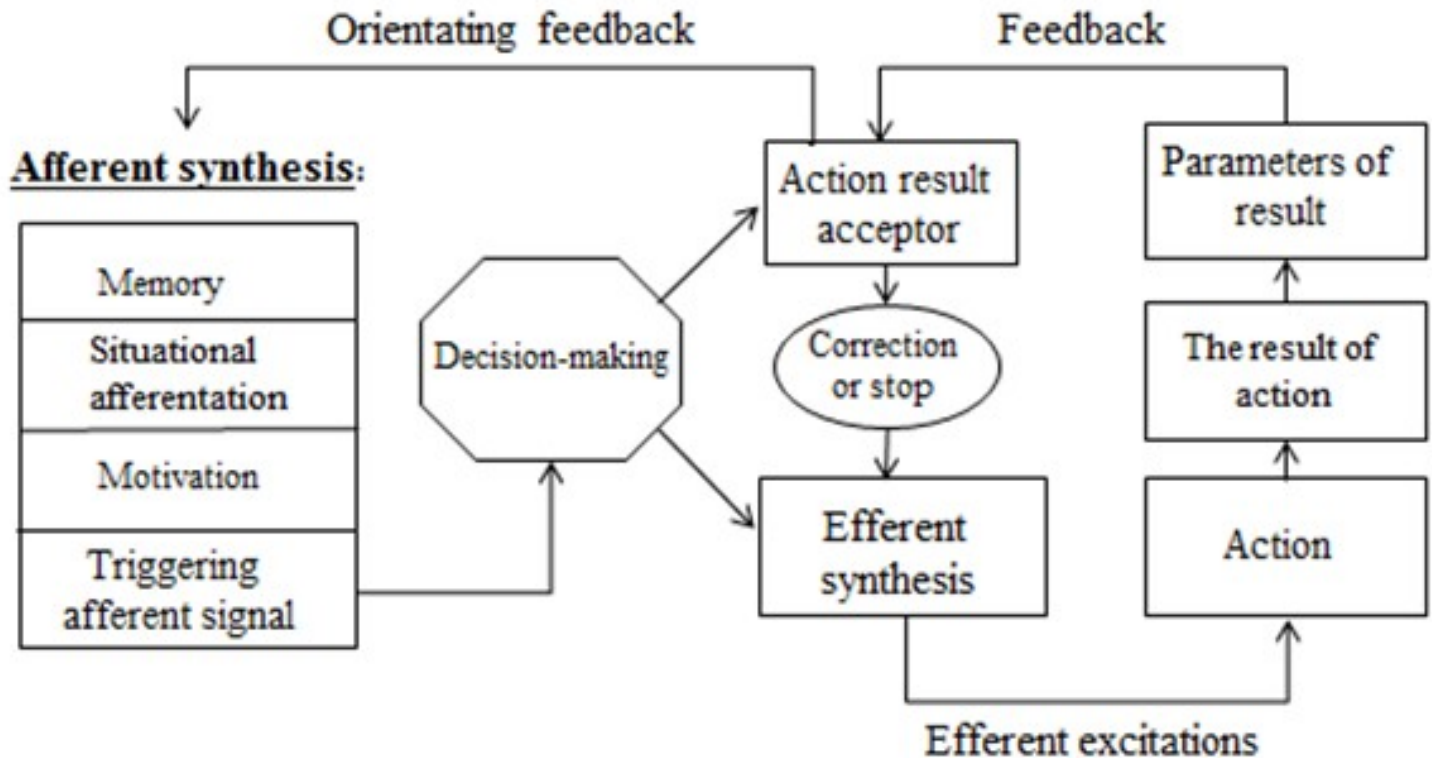


The concept of **P. K. Anokhin** about functional systems, where the system in which physiological processes are involved is an internal reflection of the external environment.

Systemic processes of a **behavioral act** are **informational processes** for which physiological processes act as a material carrier.

In this sense, the mental image and its neurodynamic equivalent are not only simultaneous phenomena, but they constitute an indivisible whole.

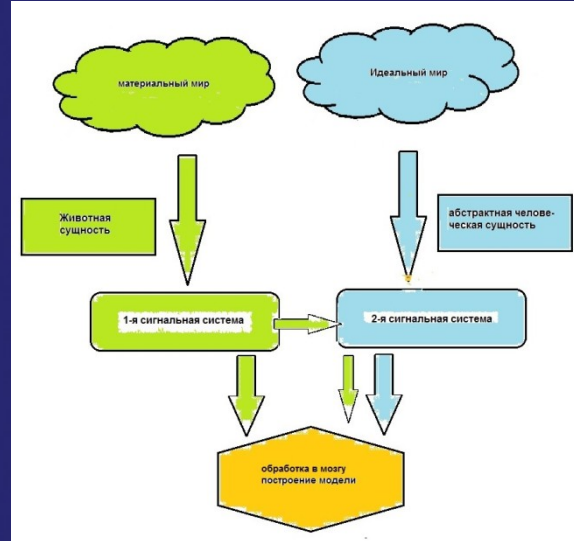
# Theory of functional systems (P. K. Anokhin)



# Features of human HNA

I.P. Pavlov singled out specific human types of HNA in depending on the prevalence of the 1st or 2nd signaling systems in perception of reality.

The strength of the nervous processes in the cortical system, where the traces are recorded in the form of kinesthetic, acoustic or optical symbols, accumulating traces of direct effects on a person, was taken into account as the main indicator.



# Features of human HNA

Pavlov attributed people with a predominance of the function of cortical projections responsible for **primary signaling stimuli** to the **artistic type**.

If the **second signaling** system turns out to be stronger in the dynamic relation, suppressing the first — to the **thinking type**.



# Features of human HNA

To the **average or mixed type**, Pavlov attributed people in whom neither 1st nor 2nd signaling systems exert a dominant influence on human behavior.

At the same time, depending on the nature of the perception of reality and thinking and art type people can be assigned to any of these types.





# Disorders of HNA and their effects



Overstrain of the main nerves processes can cause functional disorders of the central nervous system — neuroses.

The causes of neuroses are emotional stress, social conflicts, strong physical and psychological influences, insurmountable obstacles, severe and long-term illnesses.

As a result of such influences, there is a "breakdown" of the HNA, which can be expressed in a sharp predominance of the excitatory or inhibitory process.

With a predominance of excitement, inhibitory conditioned reflexes are suppressed, motor and autonomic excitement appears.

With the predominance of the inhibitory process, positive conditioned reflexes are weakened or disappear.

Weakness, drowsiness appear, motor activity is limited.

# Disorders of HNA and their effects

Human labor activity is the basis of its existence.

Any work takes place in a specific environment that determines working conditions.

In each type of labor process there are elements of physical labor (in which muscle load is performed) and elements of mental labor.

Therefore, any work is divided according to its severity (4-6 groups) and intensity (4-6 groups).

As a rule, any work is accompanied by an increase in nervous tension against the background of decreasing muscle efforts.

New types of work have appeared — work with a sharp restriction of physical activity (the work of an astronaut in conditions of weightlessness, when the gravitational load on the locomotor apparatus is completely absent).



# Disorders of HNA and their effects

Such work is carried out in **hypokinesia** conditions, which is the cause of asthenization of the body and is accompanied by muscle atrophy, which is a risk factor for cardiovascular diseases.

The reason for the increase in **nervous** and **psycho-emotional stress** in modern production is not only a decrease in the proportion of physical labor and muscle activity.

The main thing is an increase in information that needs to be processed in the face of a growing time pressure, an increase in the scale of production, an increase in the speed of production processes, and an increase in responsibility.



# Disorders of HNA and their effects



The consequence of excessive psycho-emotional stress there may be increased fatigue, autonomic neuroses, mental disorders, cardiovascular diseases, gastric ulcer, etc.

As a result of psycho-emotional stress, bad habits are often formed, which include smoking and drinking alcohol.

In this way, a person tries to disconnect from the surrounding reality or relieve emotional stress.

When **smoking**, the main damaging factor is nicotine and carbon monoxide, which, getting into the blood, bind to hemoglobin, disrupting the transport of O<sub>2</sub> to the tissues of the body.

The cells of the nervous system and myocardium are especially sensitive to a lack of oxygen (hypoxia).

# Disorders of HNA and their effects



Carbon monoxide and nicotine directly affect nerve cells, as well cells of the heart and blood vessels.

The consequence is a violation of the functions of the nervous system, as well as sclerosis and vascular thrombosis.

As a result of alcohol intake, a special state of the psyche arises — euphoria, which is characterized by an elevated mood, anxiety and worries disappear, false self-confidence appears (one's strengths and capabilities are overestimated), pleasant relaxation, drowsiness can occur.

The danger of euphoria lies in the fact that a person who has experienced this condition several times gradually develops the desire to experience it constantly (alcohol dependence is formed).

# Disorders of HNA and their effects

Alcoholism, like any addiction, makes a person socially inferior and often dangerous for society (since the attitude of a person to the environment changes completely, weak character, deceit, dishonesty, inability to mental and physical work develop).

When a person's existence is meaningless, there is no work, study, family, positive emotional coloring of activity, then he makes up for this deficiency artificially (intake of alcohol, toxic substances, drugs).

Receiving pleasure from this, he seeks to repeat it, thus developing a conditioned reflex of negative quality.

NO DRUGS



## **5. Doctrine of I. P. Pavlov's about I and II signaling systems**

# Doctrine of I. P. Pavlov's about I and II signaling systems



Common to animals and humans are analysis and synthesis direct concrete signals of objects and phenomena of the surrounding world, coming from visual, auditory, and other receptors of the body and constituting the first signaling system.

In the process of work and social development, a person has appeared, developed and improved a **second signaling system associated with verbal signals and speech.**



# Doctrine of I. P. Pavlov's about I and II signaling systems

This signaling system consists of the perception of words — heard, spoken (aloud or silently) and visible (while reading).

The ability to understand and then pronounce words develops in a child as a result of the association of certain sounds (words) with visual, tactile and other impressions of external objects.



# Development of signaling systems in a child

**The development of signaling systems** in a child goes through several stages.

The formation in the cortex of temporary connections of the first signaling system in a child begins several days after birth.

At 7-10 days of age, the first conditioned reflexes can be developed.

By the end of the 1st month, conditioned reflexes to sound, and on the 2nd month — on light signals.



# Rate of conditioned reflexes formation

**The rate of formation of conditioned reflexes** increases rapidly during the first months of life.

At the age of 1 month, to develop a conditioned reflex, it is necessary to produce many combinations of conditioned and unconditioned stimuli, at 2-4 months — only a few combinations are enough.

Conditioned inhibition is developed at 2-4 months, while it occurs earlier differentiating inhibition, late — retarded.



# Signaling systems

**The first signs of development of the 2nd signaling system** appear in a child during second half of 1 year of life.

As it develops, it begins to serve as a means of active communication between the child and other people.

**The second signaling system** is inextricably linked with the social life of a person.

Verbal signaling, speech, language are the means of communication between people. Outside of society, without communication with other people, the second signaling system does not develop.



# Signaling systems

A person becomes a person only in the society of other people. In the process of communication, a person determines the guidelines for his behavior, constantly checks what he is doing with what others expect from him, coping with their opinions, feelings, requirements.

According to modern psychology, the prevailing assessment of one's own "I" (**self-esteem**) is the result of comparing what each observes in himself, with what he sees in other people, and with what, as it seems to him, other people see in him.

We are talking about the "**reference group**", with the opinion of which a person is considered.



# Signaling systems

The upbringing of goals, aspirations, character is determined by the influences of reference groups.

The **personality structure** includes 3 indicators:

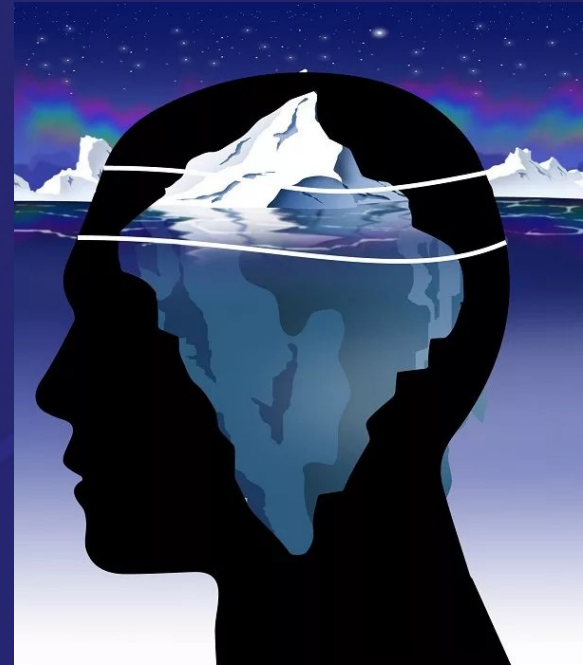
- self-esteem;
- expected score;
- personality assessment group with whom man is forced to be considered.



# Signaling systems

The person himself often does not even suspect about their presence, but a person checks against this **"internal manometer"** of personality assessments, entering into communication, actively acting.

It always happens, but predominantly subconsciously.



# Signaling systems

To **deliberately manage processes education**, prevention and treatment,

it is necessary to clearly imagine the action of these unconsciously emerging forms of managing behavior and well-being, to pay attention to the entire system of assessments that a person characterizes himself and others with, to see the dynamics of their changes.

That is, the **social essence of the individual must not be overlooked**. Early childhood is especially important; establishing normal relationships with peers will help in the future rapid adaptation to the environment.

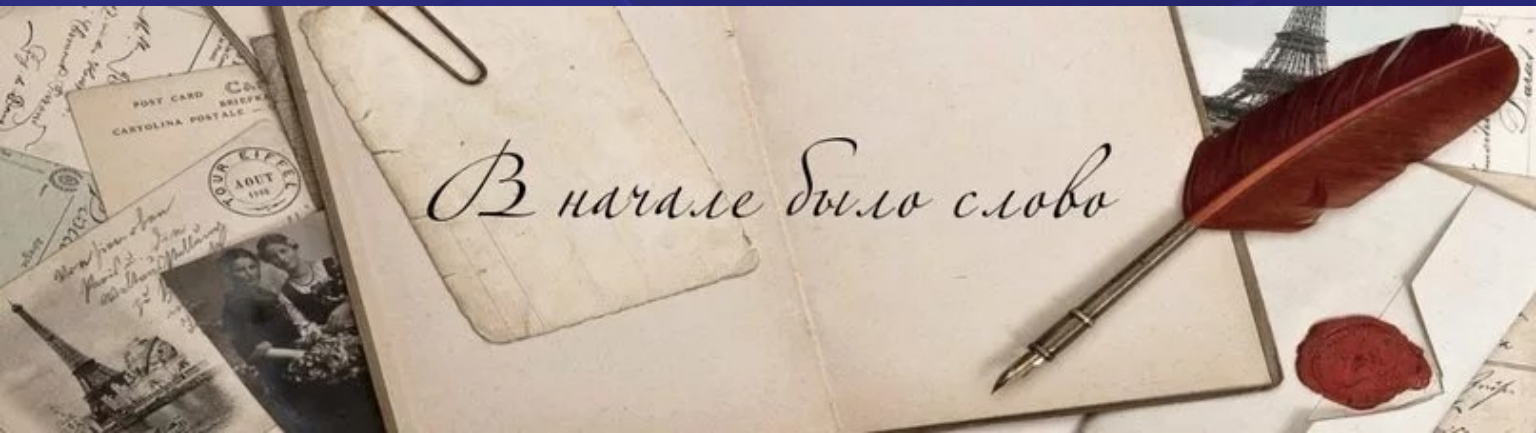




# Signaling systems

Speaking about the second signal system, it should be remembered that a **word** is perceived by a person not just as a separate sound, but as a definite concept, that is, its semantic meaning is assimilated.

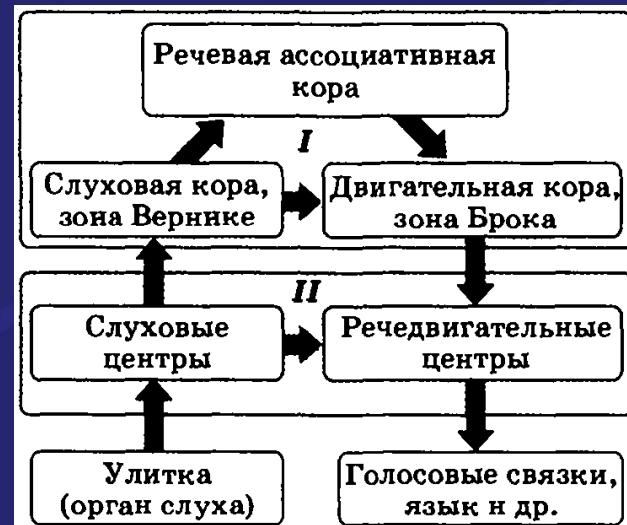
The **word** is a powerful reinforcement on the basis of which strong conditioned reflexes can be formed.



# Signaling systems

**The 1st and 2nd signaling systems are inseparable;** in a person, all perceptions, ideas and most sensations are designated by a word.

That is, excitations of the 1st signal system caused by specific signals from objects and phenomena of the surrounding the world, are transmitted in the 2nd signaling system.



# Signaling systems

There are various forms of reflection of the surrounding reality by the thinking brain.

**Concretely sensory reflection**, which is manifested by sensations, perceptions, representations, is relatively simple.

More complex — **abstract-generalized reflection** of the surrounding world, manifested by logical thinking — in concepts, judgments and inferences arising from basis abstractive work human brain.



# Signaling systems

Thus, the patterns of conditioned reflex activity are common to humans and animals.

In this case, conditioned reflexes are formed as a result of the action of external and internal stimuli (sound, light, heat, cold, metabolic products, etc.).

Such stimuli constitute the **first signaling system**.

In humans, due to the social nature of life and the presence of speech, a new property of higher nervous activity has arisen:

the ability to perceive words spoken aloud and silently, audible and visible (when reading).

These special influences constitute the **second signaling system**.

Verbal designations replace the impact of real objects and phenomena.

Verbal signaling made possible the distraction and generalization of phenomena (concepts).



# Signaling systems

Improvement of the second signal system in humans occurs continuously in the learning process.

Due to the first signaling system

a **concrete-sensory perception** of the surrounding world is achieved in the form of sensations and representations.

The development of the second signaling system provided an **abstract-generalized perception** of the surrounding world in the form of concepts, judgments, and inferences.

The first and second signaling systems are closely related to each other, since the second signaling system arose on the basis of the first.

In humans, the second signaling system prevails over the first. However, different people have different relationships between them.



# Types of HNA based on dominance of signaling system

This helped to identify four special human type HNF (by **I. P. Pavlov**):

**art type** — second signal the system is less dominant over the first. People of this type are characterized by concrete and figurative-emotional thinking. They are distinguished by vivid representations and fantasies;

**thinking type** — the second signal system prevails over the first to a greater extent. These people are reasonable, inclined to analyze all phenomena and events;

**mixed type** — relative balance between systems;

**genius type** — exceptional development of the first and second signaling systems. These people are equally capable of artistic and scientific creativity.



**Thank you  
for your attention!**

