2a. Biological bases of behavior
A. Behavioral genetics

Study methods

Genetic methods are used to assess the effect of genetic and environmental factors on individual differences (focusing on character traits and behavior);
Their purpose is to identify certain specific genes responsible for genetic influence.
Genetic methods used in humans

1) **twin studies** - are based on natural occurrence that leads to the birth of identical (monozygotic) or fraternal (dizygotic) twins.

Utility:
- the proportion of behavioral variation between mono- and dizygotic twins can provide information on the influence of a genetic factor;
- e.g. significant psychological similarities between identical twins are probably due to biological variables; significant psychological differences are probably due to environmental ones;

Limits:
- small number of subjects available;
- the method does not provide a precise evaluation of the genetics to environment ratio in the development of behavior.
2) the adoption methods

→ the adopter version (the retrospective approach):
- it starts from ill children and evaluates whether their parents (natural or adoptive ones) also have the disease; if the proportion of the ill natural parents exceeds that of the adoptive parents, the genetic factor plays a more important role;

→ the adoptee version (the prospective approach):
- it starts from ill parents and evaluates the degree in which their children (biological or adopted) have the disease; if the ratio of diseased biological children exceeds that of adopted children, the genetic factors play a more important role;

→ the cross-fostering version:
- it compares adopted children with healthy biological parents and ill foster-parents with adopted children with ill biological parents and healthy foster-parents; if the prevalence of disease is higher in the first group, environment plays the more important role.
Genetic contribution on mental illnesses

Example: on the determinism of schizophrenia intervene:

a) the genetic background:
   - family aggregation of this disease (raised vulnerability to its onset in relation to the degree of kinship with the ill relative);

b) family theories:
   - the role of ambiguity of parental emotional messages ("emotional divorce") (Bowen, 1978);
   - affective ambivalence ("double bind") (Bateson, 1956);
   - explicit permissiveness doubled by implicit ban ("rubber fence") (Wynne, 1958).
B. Neuroanatomical and neurophysiological correlates of behavior

There are a wide variety of anatomical structures and physiological processes involved in behavior:

- activity of central nervous system (CNS) neurons which have exclusively motor functions;
- nervous structures with roles in:
  - in affectivity (limbic system, paleocortex);
  - integrative vegetative (hypothalamus);
  - volitional (paleocortex, frontal lobe).
Eating behavior

Hypothalamus = central role

- *the lateral area:*
  - *stimulating* \(\rightarrow\) intense hunger, exaggerated appetite \(\rightarrow\) obesity;
  - *destruction* \(\rightarrow\) anorexia \(\rightarrow\) cachexia and death;
- *the ventromedial nucleus of the lateral area: satiety center*
  - is stimulated by increase in the metabolic resources
    \(\rightarrow\) interruption of food ingestion;
  - impairment of this center (by trauma or surgery) \(\rightarrow\) overnutrition \(\rightarrow\) obesity.

Limbic system:

- septum and amygdala – involved in emotional correlates of food;
- hippocampus – memorizing the taste of food;
Hypothalamus-hippocampus circuits initiate the occurrence of certain behaviors centered on acquiring food or in realizing the difference between various types of foods.

The behavioral plan is transmitted to the neocortex, which, in association with the paleocortex complete it (this depends on the actual possibilities of acquiring food).

The neocortex initiates also the motor plan to accomplish the eating behavior. The movement plan is transmitted to the cerebellum and is influenced by basal ganglia.

A permanent feedback is sent to the cerebral cortex, basal ganglia and to the cerebellum, via thalamus.
Behavior in emotional states

Emotions initiate:
- immediate behaviors (“fight or flight” reactions);
- behaviors on the long run (e.g. post-traumatic stress disorder).

Affective memory, which explains many behavioral reactions, is provided by:
- temporal-occipital associative areas;
- the prefrontal lobe;
- the limbic system;
- amygdala;
- the hippocampus.
The neurophysiologic basis of emotions

Limbic system

- “the circuit of Papez” - process and renew emotions;
  - behaviors generated by affective states
  - structures involved:
    - the hippocampus;
    - the fornix;
    - the mammillary bodies;
    - the Vicq D’Azyr tract;
    - thalamus (anterior nuclei);
    - gyrus cinguli;
- amygdala: role in fear, the processing of primary emotions;
- hippocampus: role in affective memory and in modulating emotions;
- frontal lobe: role in interpreting and analyzing emotions.
C. The importance of cerebral anatomical structures in accomplishing various behaviors

**Cerebellum**: - modulates muscular contractions, balances postural tonus and automatic, semiautomatic and voluntary muscle contractions;

**Thalamus**: - involved in regulation of emotions;
    - relay for sensitive tracts that reach the cortex;

**Hypothalamus**: - involved in eating, drinking, sexual behavior;
    - involved in affective-emotional behavior;
    - key role in stress responses, such as flight (anterior hypothalamus) or fight (ventromedial nucleus);
    - involved in the secretion of endorphins.
Limbic system

**Hippocampus**: - role in affective memory and emotional modulation;
   - lesions at this level $\rightarrow$ anterograde amnesia
     (of recent events, e.g. in Alzheimer's disease);

**Amygdala**: - involved in:  - eating, sexual behavior;
   - emotional coping ;
   - complex emotional states;
   - bilateral injuries decrease aggressive behavior;
   - single / bilateral ablation of the amygdala $\rightarrow$
     reduction of aggressive behavior;

**Striate bodies**: - adapt automatic and semiautomatic movements, in
tight connection with motor areas.
Frontal lobe:
- role in acknowledging instinctual behaviors and emotions;
- elaboration of behavioral plans;
- integration between personality and thought;
- superior integration of emotions and motivations;
- lesions at this level → disorders of thinking, memory, emotions, language (Broca aphasia = difficulty in formulating words);

Temporal lobe:
- lesions at this level:
  → memory and affective disorders;
  → language disorders (Wernicke aphasia = impaired word comprehension).
Cerebral hemispheres

Brain specialization

- left hemisphere (frequently dominant):
  - rational understanding and mental reconstruction of reality);

- right hemisphere (non-dominant):
  - emotional, artistic impressions, memories with emotional content).
Complementarity

Cerebral hemispheres interact and complete each other with the aim to integrate behavior in a coherent unit. The splitting of the two hemispheres leads to the disintegration of the unity of the psyche.

Disconnection (split-brain) syndrome (Sperry experiment, 1968) = severing the corpus callosum in epileptic patients) highlights the importance of complementarity.

Neuroplasticity

= the ability of the brain to adapt and reorganize under the action of environmental stimuli. Within certain limits, the nervous system can be modified and refined by the experience accumulated over many years. The brain can be trained to re-learn and imitate previous learning.
2D. Neurochemical bases of behavior

Neuromodulators

= substances responsible for the transmission of information from one neuron to another and from neurons to striated or smooth muscle fibers or to some glandular cells;

- are involved in behavior (inhibit or stimulate behavior, or are specific to certain kind of behavior).
Acetylcholine (Ach)

- in the periphery:
  - role in transmitting nervous influxes to muscles and glands;
  - acetylcholine deficit $\rightarrow$ myasthenia gravis (skeletal muscle motor deficits and fatigability);

- at central level:
  - involved in mood disorders (based on the imbalance acetylcholine - noradrenalin in the limbic system and cerebral cortex);
  - high ratio $\rightarrow$ depression; low ratio $\rightarrow$ mania;
  - involved in Alzheimer disease, Down syndrome (the degradation of Ach neurons);
    - role in memory (Ach receptors are found in large quantities in the hippocampus).
Adrenaline (Ad) / Noradrenaline (NAd)

- role in: - "fight or flight" response;
  - considered as a “signal modulator” (encoding the signal / noise ratio: high ratio = more signal, more complicated processing; low ratio = less signal, more easily processed; allows a better focus of attention).

Adrenaline:  - body temperature regulation;
  - arterial pressure regulation;
  - respiratory rate regulation;
  - eating behavior;

Noradrenaline:  - sleep-wake cycle;
  - anxiety;
  - mood disorders.
Dopamine (Dop)

- at peripheral levels - involved in motor coordination;

- at central levels (in excess)- involved in the etiology of schizophrenia
  (arguments: - Dop receptor blockers are efficient in the treatment of schizophrenia;
  - brain of schizophrenic patients containing more of Dop receptors;

- associated with mood changes:
  - in large amount → maniacal states;
  - in small quantities → depression;

- is a neuromodulator of drug addiction (doing drugs enhances dopamine secretion within the limbic system → increase the motivation to use drugs).
Serotonin (5HT)

- involved in **behavioral inhibition** (5HT 1A receptors situated in the median and dorsal ripe nuclei and in the hippocampus, septum and some cortical strata; anxiolytic drugs stimulate these receptors);

- associated with **depression** (5HT 1B receptors; antidepressant drugs inhibit these receptors);

- involved in the occurrence of migraine (5HT 1D receptors influence cerebral vascularization);

- has **dual effects**: inhibitory (cerebral cortex) and excitatory (limbic cortex);

- role in the **mechanism of sleep** (together with NAd and Dop): serotonin induces slow-wave sleep;

- involved in **transmission of pain**.
Gamma-aminobutyric acid (GABA)

- the most important CNS inhibitory neuromodulator;
- involved in the mechanism of sleep;
- associated with affective disorders (depression);
- influences motivational behavior;

Enkephalins and endorphins

- included in a distinct class of neuropeptides under the label of "endogenous opioids";
- role in pain modulation (decrease pain sensation);
- stimulative effect on immunity;
- “mediators of pleasure”;
- involved in water homeostasis, regulation of food ingestion.