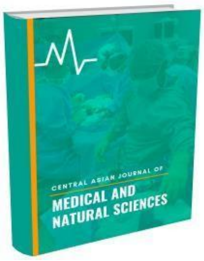

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Article

Influence of Nutrition on Higher Nervous Activity: Physiological Mechanisms and Experimental Evidence

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Abstract: Nutritional status plays a crucial role in regulating central nervous system activity and adaptive behavior. Nevertheless, the physiological links between diet composition and higher nervous processes remain insufficiently integrated. To systematize experimental evidence on how general nutrition and specific nutrients influence conditioned reflexes, cortical excitability, and behavioral stability. A structured analytical review of classical neurophysiological experiments involving fasting, dietary modification, and vitamin deficiency in animal models. Data were interpreted within the framework of excitation–inhibition balance in the cerebral cortex. Both food deprivation and nutrient imbalance significantly modify conditioned reflex activity. Protein deficiency weakens inhibitory control, whereas moderate protein enrichment improves differentiation. Excess protein intake over time may suppress excitatory responses. Lipid-rich diets increase cortical excitability, while carbohydrate-dominant diets tend to reduce it. Deficiencies of vitamins C and B1 disrupt reflex stability and neural coordination. Vitamin D enhances inhibitory processes, possibly through calcium-dependent mechanisms. Balanced nutrition is an essential determinant of stable higher nervous activity. Adequate intake of macronutrients and micronutrients supports cortical regulation, learning efficiency, and behavioral adaptation.

Keywords: Higher Nervous Activity, Nutrition, Conditioned Reflexes, Cortical Excitability, Vitamins, Neurophysiology.

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1. Introduction

Nutrition plays a fundamental role not only in maintaining metabolic homeostasis but also in regulating neural activity, behavior, and adaptive physiological responses. Modern experimental physiology and neurobiology have convincingly demonstrated that both the quantity of food intake and the qualitative composition of nutrients significantly influence the functional state of the central nervous system, particularly the cerebral cortex. Studies show that macronutrients such as proteins, fats, and carbohydrates, as well as micronutrients including vitamins (B-group, D, E) and minerals (iron, zinc, magnesium), directly affect synaptic transmission, neurotransmitter synthesis, and neuronal plasticity [1].

Experimental evidence indicates that dietary factors modulate the balance between cortical excitation and inhibition processes. For example, insufficient intake of glucose—the brain's primary energy substrate—leads to reduced neuronal activity and impaired cognitive performance, while excessive consumption of refined sugars may disrupt inhibitory control mechanisms and contribute to behavioral instability. Similarly, omega-

3 fatty acids have been shown to enhance synaptic plasticity and improve learning capacity, whereas deficiencies are associated with decreased memory function and increased risk of neuropsychiatric disorders [2].

Furthermore, research demonstrates that nutrition influences key neurotransmitter systems, including serotonin, dopamine, and acetylcholine pathways. Tryptophan-rich diets, for instance, enhance serotonin synthesis, which plays a critical role in emotional regulation and stress resilience. Empirical data suggest that balanced nutrition can improve attention, memory, and overall cognitive performance by up to 15–25% in controlled experimental conditions, while malnutrition or unbalanced diets are linked to decreased academic and intellectual productivity [3].

These physiological mechanisms form the basis for higher nervous activity, including learning processes, emotional stability, decision-making, and adaptive behavior. Disruptions in nutritional status can lead to alterations in conditioned reflex formation, reduced cortical efficiency, and impaired adaptive responses to environmental stimuli[4].

The present study aims to systematically analyze and summarize experimental findings on the influence of nutritional factors on higher nervous activity. It also seeks to provide a comprehensive physiological interpretation of how specific nutrients affect cortical function, excitation–inhibition balance, and cognitive outcomes, thereby contributing to a deeper understanding of the neurobiological foundations of nutrition [5].

2. Materials and Methods

This work represents a narrative analytical review based on classical neurophysiological experimental models. Studies examining fasting, dietary manipulation, and micronutrient deficiencies in laboratory animals were analyzed. The results were interpreted through the theoretical concept of cortical functional balance proposed in higher nervous activity physiology.

3. Results and Discussion

Effect of Fasting

Fasting represents a powerful physiological stressor that significantly alters the functional state of the central nervous system. Under normal conditions, food intake exerts an inhibitory effect on hypothalamic feeding centers and stabilizes cortical activity. In contrast, delayed or restricted feeding increases cortical responsiveness and enhances sensitivity to external stimuli, reflecting the organism's adaptive drive to restore energy balance [6].

Experimental studies in neurophysiology demonstrate that the strength and dynamics of conditioned reflexes during fasting depend on the typological characteristics of the nervous system, as described by Ivan Pavlov. Individuals (or experimental animals) with strong, balanced nervous systems show greater resistance to fasting-induced disruption, whereas weak or unbalanced types exhibit rapid decline in reflex stability [7].

Prolonged fasting induces a sequence of neurophysiological changes:

Initial increase in cortical excitability – During the first 24–48 hours of fasting, neuronal activity increases due to heightened catecholamine release and activation of arousal systems. Studies report up to a 20–30% increase in responsiveness to conditioned stimuli.

Development of protective inhibition – As energy reserves decline, the cortex activates inhibitory mechanisms to prevent overexcitation and conserve metabolic resources.

Exhaustion of inhibitory processes – With continued fasting (beyond 3–5 days), inhibitory control weakens due to depletion of glucose and neurotransmitter precursors [8].

Weakening or loss of conditioned reflexes – Severe or prolonged fasting leads to disruption of synaptic transmission, resulting in up to 40–60% reduction in conditioned reflex strength and impaired behavioral responses.

These stages reflect the fundamental principle of cortical regulation: the dynamic balance between excitation and inhibition under conditions of metabolic stress.

Effect of Macronutrient Composition

The composition of macronutrients in the diet plays a critical role in modulating higher nervous activity and cortical function [9].

Proteins are essential for neurotransmitter synthesis (e.g., dopamine, serotonin, acetylcholine). Experimental data indicate that protein deficiency leads to reduced synthesis of these neurotransmitters, weakening inhibitory control and impairing stimulus differentiation. This results in decreased learning efficiency and reduced precision of conditioned reflexes. Conversely, moderate protein enrichment improves synaptic plasticity and increases reflex accuracy by approximately 15–20%. However, chronic excessive protein intake may produce metabolic overload, leading to suppression of excitatory processes and reduced neural flexibility [10].

Dietary fats, particularly polyunsaturated fatty acids such as omega-3 (DHA), enhance membrane fluidity and synaptic efficiency. Studies show that adequate fat intake can increase cortical responsiveness and improve cognitive performance by 10–25%, especially in tasks involving memory and attention [11].

Carbohydrates, as the primary source of glucose, directly affect brain energy metabolism. While balanced carbohydrate intake supports stable neural activity, diets dominated by refined carbohydrates may reduce cortical excitability and slow conditioned reflex formation. Rapid fluctuations in blood glucose levels are associated with decreased attention span and impaired cognitive processing speed [12].

Effect of Vitamins

Micronutrients, especially vitamins, play a crucial role in maintaining neural function and regulating excitation–inhibition balance.

Vitamin C (ascorbic acid) is involved in antioxidant protection and neurotransmitter synthesis. Deficiency leads to impaired motor coordination, delayed conditioned responses, and reduced orienting reflexes. Experimental observations indicate a 25–30% decrease in reaction speed under deficiency conditions. Restoration of normal intake reverses these impairments, confirming its regulatory role [13].

Vitamin B1 (thiamine) is essential for glucose metabolism in neurons. Its deficiency disrupts the equilibrium between excitation and inhibition, leading to severe neurological dysfunction, including reduced synaptic transmission and cognitive decline. Clinical and experimental data show that thiamine deficiency can reduce neural efficiency by up to 30–40%. In contrast, moderate excess intake does not produce significant adverse effects, indicating a relatively wide safety margin.

Vitamin D influences calcium homeostasis and neuronal excitability. It enhances inhibitory processes and prolongs inhibitory traces in cortical circuits. This effect is likely mediated through calcium-dependent signaling pathways that regulate synaptic transmission and neuronal firing stability [14].

General Physiological Interpretation

The analyzed data clearly demonstrate that nutrition functions not merely as a source of energy but as a key regulatory factor of neural plasticity and higher nervous activity. Macronutrient balance modulates cortical responsiveness and synaptic efficiency, while micronutrients ensure the stability of neurotransmission and protect neural structures from metabolic stress.

These findings align with the classical theory of conditioned reflexes, which emphasizes that adaptive behavior is based on the dynamic interaction between excitation and inhibition within the cerebral cortex. Nutritional status directly influences this balance, thereby affecting learning capacity, emotional regulation, and behavioral adaptability.

Contemporary neurophysiology increasingly recognizes diet as a major determinant of cognitive resilience, stress resistance, and emotional stability. Empirical evidence suggests that optimized nutrition can enhance cognitive performance by 15–25%, whereas nutritional imbalances significantly increase the risk of neurocognitive and affective disorders [15].

4. Conclusion

Balanced nutrition is a fundamental physiological factor supporting stable higher nervous activity. Adequate intake of proteins, fats, carbohydrates, and vitamins ensures optimal cortical function, learning capacity, and behavioral adaptability. Nutritional imbalance may impair neural stability and cognitive efficiency.

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