

Biological Requirements Behind Brain Function and Mind Formation

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Abstract

The major conflict in the old philosophy of mind was the material or supernatural origin of mind and consciousness. Based on new neuroscientific findings, philosophers have become more cautious in considering the immaterial origin of the mind. At present, the main debate in the philosophy of mind is the dependence or independence of mental phenomena on information and signals received from the outside world. If we consider the brain as a living organ and the mind as a product of brain activity, the need of this organ for matter and energy obtained from nature has been neglected as signals. Gut hormones, food-derived nutrients, and gut microbiome effects influence brain functions. Therefore, it is impossible to consider a brain separated from the surrounding world as long as it is alive and needs nutrient flow.

Key Words: mind, internalism, externalism, nutrients, microbiome

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117

Philosophers have long discussed whether an embodied brain in vat maintains awareness. It has long been postulated that a person's experiences are characterized by the interaction between the brain, the body, and the environment. However, recent findings showed that the brain without sensory input may show some levels of awareness in an offline mode. In 2020, Bayne et al. explained situations in which the brain has no or reduced communication with the outside world including hemispherectomy, ex-cranio brain, and cerebral organoids. They suggested that the brain might be able to show the island of awareness under these situations by using the indirect index of awareness, the perturbational complexity index (Bayne *et al.*, 2020). Despite the similarity with the internalistic point of view, they proposed that the independent islands of awareness in a disconnected brain may be in line with just some levels of consciousness. Recently,

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it has been shown that consciousness is a memory system to make decisions unconsciously. After half a second, we consciously remember doing them. Therefore, before the sensory perceptions leads to a decision, the brain has started its function (Budson *et al.*, 2022).

Several decades ago, the main question in mind philosophy was the material or immaterial origin of the mind. During the 17th century, Descartes skeptically stated that the existence of everything can be doubtful, except for thought and mind. His famous quote was "*Cogito ergo sum*" (*I think; therefore, I am*). He holds that the origin of the mind, and soul, is immaterial and supernatural. His theory was named "Dualism" representing the separation of body and mind. Despite doubting the reality of the body, he suggested the pineal gland as the site for the connection of the soul to the brain. This suggestion was probably because he assumed that most parts of the brain are in pairs, and the pineal gland is just one. However, Descartes's argument has a serious bug: how does an immaterial thing, the mind, influences the body as a physical material? Modern neuroscience proposes that mind qualia including fear, pain, emotions, and perceptual states are physical qualities which are emanated from brain activity and influence the body. There is convincing clinical evidence that damage to distinct parts of the brain can affect mental faculties. Although this physicalist view is not error-free, it is now more dominant among scholars (Tryon, 2014).

During the 1980s, Hilary Putnam, mentioned Descartes' skeptical view about the reality of the world outside the mind, in his "brain in a vat" hypothetical experiment. He assumed a brain, separated from the body, in a container full of nutrients and factors necessary for its survival and function. The brain was connected to a computer via electrodes. All emotions, perceptions, memories, and thoughts were induced by the computer in the separated brain. Thus, there was no need for external signals through the body. Based on this assumption, our understanding of the reality of the world can be an illusion induced by a computer. This idea was represented in the Matrix series of movies by the Wachowski brothers. As one of the externalism pioneers, Putnam, believed that we cannot be a "brain in the vat" because we could not realize that "we are a brain in the vat" unless commanded by the inducing computer (Forbes, 1995).

At present, the main discrepancy in the philosophy of mind is less about its material/immaterial origins, but more about the intrinsic or both intrinsic and extrinsic origin of the mind. Internalists theorize that events causing the formation of mental phenomena in the Central Nervous System (CNS) are located inside the person's body. They consider the mind is just dependent on the internal characteristics of an individual. In contrast, externalists propose that factors, other than intrinsic parameters, interact with messages from the surrounding environment and lead to the formation of mind qualia. Putnam argued the effect of external reality on the meaning of terms in the mind by the

twin earth argument in his article, *"The Meaning of "Meaning"* (Putnam, 1975). Avicenna, a famous Iranian philosopher in the 11th century, might be the first who discussed a special kind of consciousness that is different from being aware of our body. Thus, by keeping a person suspended in a dark space without receiving any signal from the surroundings, he/she will be still able to be aware of his/her existence. Although similar to Descartes, Avicenna believed that the mind is located in an immaterial soul, while the floating man argument proposed that human needs no external signal for consciousness (Alwishah, 2016).

All theories confirming the independent role of the brain in the formation of mind and consciousness ignore the requirements of the living brain. They have assumed that the brain communicates with the outside world just with sensory signals, which in Putnam's argument was replaced by a computer.

Although life is known, its definition has been disputed among philosophers from Aristotle to recent scientists. Biologists determine three main traits of life which are common among all living organisms to avoid philosophical conflicts about life definition: 1) Methods of obtaining energy to maintain their structure and functions; 2) making a new copy of themselves which is the most important mission of living beings; 3) The capacity to evolve for better compatibility with their environment. These characteristics cause huge biodiversity on earth throughout the history of life. Among the elements on earth, 25 are present in life-forming biomolecules, mainly carbon, hydrogen, oxygen, nitrogen, sulfur, and phosphorus. Chemical reactions tend to move toward more entropy. However, life depends on reactions leading to more complex and ordered molecules. Two types of chemical reactions are performed at the cellular level, reactions producing energy and those consuming energy. Energy-consuming reactions are accomplished at the expense of energy-producing ones to form compounds that are necessary for maintaining the structure, functions, and homeostatic mechanisms. Homeostasis is needed to stabilize the internal environment of living organisms. Plants trap and store sunlight energy in the chemical bonds of some biomolecules. Other organisms use these energetic compounds as a source of energy. After death, some microscopic organisms convert biomolecules into simple organic compounds. These materials return to nature and are re-used by plants as a source of building material to make new biocompounds. Therefore, the main cellular reactions are dependent on energy-generating reactions, which in turn, are directly or indirectly dependent on the energy trapped by plants. Plants, likewise, need sunlight and matter provided by the earth to produce biomolecules for themselves and other living organisms (Molnar, 2019).

The brain consists of over one hundred billion neurons, and the main function of each is to connect to hundreds and thousands of other neurons, through special junctions called synapses. This network

provides a huge information platform. The findings of modern neurology show the importance of neural connections (i.e. connectome) in the formation of mental phenomena including consciousness, memory, intentions, and emotions. The number of these connections increases until the age of two when sensory perceptions are fully generated. They then gradually decrease until adulthood, while the quality of connections improves simultaneously (Cao *et al.*, 2017). The connectome is dynamic; every perceptual experience causes the formation of new connections. Reactivation of these neural circuits results in the recreation of those emotional or perceptual experiences as memory. However, if these connections are not used, they gradually disappear. Therefore, it is not an overstatement to say: "I am my connectome" (Seung, 2012).

Neurotransmitters are chemical compounds that play major roles in communication between neurons, among which, three biogenic amine neurotransmitters, dopamine, norepinephrine, and serotonin are more important in the formation of cognition and emotions (Kruk and Pycock, 1991). Norepinephrine (NE), as the main postganglionic sympathetic neurotransmitter, has a known effect on attention, emotion, decision-making, and creating and regulating awareness. Norepinephrine is high in awake individuals while it declines during sleeping (Baloyannis, 2021). It has been shown that norepinephrine also links visual awareness to surrounding world events (Gelbard-Sagiv *et al.*, 2018). Dopamine-producing neurons -dopaminergic neurons- also decrease in patients with impaired consciousness and those under anesthesia in some brain parts. Increased production of dopamine is associated with diseases such as schizophrenia and related hallucinations (Brisch *et al.*, 2014). Serotonin is one of the most important neurotransmitters and it is involved in the regulation of emotions, moral judgments, memories, mood, appetite, and sleep. Serotonin-enhancing drugs such as citalopram increase moral emotions and inhibit harmful behaviors in healthy individuals (Crockett *et al.*, 2010). Some hallucinogenic drugs such as LSD and Mescaline cause disturbances in understanding reality through the overactivation of serotonin receptors in the brain (Rolland *et al.*, 2014). In 1993, Peter D. Kramer in his book, "Listening to Prozac" revealed the philosophical aspects of administering the antidepressant fluoxetine or Prozac, which causes dramatic alterations in people's personalities and cognition. Even some patients treated with fluoxetine stated that they no longer recognized their new selves (Kramer, 1994).

Mystical, philosophical, and moral thinking is not the main function of the brain. From an evolutionary point of view, the main function of the CNS, particularly the hypothalamus, is the hemostatic regulation of energy metabolism to survive and reproduce in harsh environments (Barrett, 2020). CNS receives signals from the metabolic tissues to perform homeostatic regulation of metabolism. These inputs are hormones of gut and fat tissues and diet-derived circulating nutrients crossing the blood-brain barrier (BBB). The brain-derived

outputs including autonomic efferent nerves, in turn, regulate digestion, gut motility, absorption, and metabolism in the main metabolic organs (Roh and Kim, 2016). Interestingly, peripheral metabolic signals such as metabolites and hormones received by CNS also can influence emotions, behavior, decision-making, motivation, and higher cognitive functions. According to evidence, metabolic diseases including obesity and diabetes cause mental dysfunction. An obesogenic diet in mice can cause defective production of a cholesterol-derived molecule in specific hypothalamic neurons, ultimately declining memory (Ramírez *et al.*, 2022). Fat tissue-derived hormone, leptin, alters motivation, learning, memory, cognitive function, neuroprotection, and reproduction by affecting different brain areas (Morrison, 2009). Another adipose tissue hormone, adiponectin decreases in obese individuals and may lead to mental disorders including dementia and Alzheimer's disease (Forny-Germano *et al.*, 2019). Obesity shows a reciprocal association with psychological conditions such as depression through the alternation of the hypothalamic-pituitary-adrenal axis (Ouakinin *et al.*, 2018)

These diet-derived signals also alter brain function. Anthelme Brillat-Savarin (1826) in his book "Physiology of Taste" has a famous quote: "Tell me what you eat and I will tell you what you are." (Brillat-Savarin, 2012). Like other tissues, the CNS not only obtains energy and nutrients from the diet but also utilizes amino acids as the precursors of the neurotransmitters. Dietary proteins and their amino acid contents play an important role in maintaining people's cognitive abilities, and low protein intake may hurt the occurrence of dementia in elder people (Glenn *et al.*, 2019). The low tryptophan diet causes a decline in serotonin synthesis in the brain, possibly affecting mood and emotions (Hughes *et al.*, 2003). Dietary omega-3 fatty acids alter expression genes involved in maintaining synaptic function and plasticity in animals. Synaptic plasticity is alterations in synapses between neurons and allows them to adapt to new information (Wu *et al.*, 2007). Diets with high saturated fats and refined carbohydrate decline brain-derived neurotrophic factor subsequently synaptic plasticity in the hippocampus (Molteni *et al.*, 2002).

There is considerable evidence for the link between mental disorders and imbalance in intestine bacteria or symbiosis. Experimental studies showed that germ-free animals have altered neurotransmitter synthesis and degradation, thus affecting stress reactivity and anxiety-like behavior (Carabotti *et al.*, 2015). Tryptophan as the precursor of serotonin is consumed by some types of intestinal bacteria. Reduction of this microbial population increases the amount of serum tryptophan or serotonin production, which finally increases mood and decreases anxiety, in animal models (Neufeld *et al.*, 2011). In the feces of patients with severe depression, either an increase in harmful microbes or a decrease in beneficial intestinal bacteria has been found (Jiang *et al.*, 2015). Humans and microbes are inextricably intertwined as if we have never been alone. It even seems that the

alteration in dietary patterns in the modern era affects our way of thinking and feeling. Fast foods with harmful fat alter the ability to learn, think and memorize and provoke depression, anxiety, and dangerous behavior in adolescents (Lowe *et al.*, 2020).

In conclusion, according to biomedical data existence of a real disconnected brain without any relationship with other parts of the body and environment is impossible. Blood supplies compounds that cross BBB to CNS. The brain reciprocally regulates nutrient flow in the body. The brain has evolved to maintain energy resources and nutrient flow in the body. Dietary compounds and metabolites of the microbiome are vital signals exerting their effects on the higher part of the brain to regulate decisions, desires, happiness, mood, and so on. Therefore, for answering, does a disconnected brain is offline and separated from the outside world? it can be stated that according to the causality rule, spontaneous formation of the mind in the brain should have an explanation. If external signals are not considered, the only remaining description may be to return to Descartes' dualism.

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122

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