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The Influence of the Gut–Brain Axis on the Mind–Body Problem

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Abstract

This article reexamines the mind–body problem through the lens of neurobiology, psychiatry, and clinical practice, advocating for a biologically embedded and systematically distributed view of mental states. Drawing on emerging research into the gut–brain axis, where it describes how microbial composition, immune signaling, and nutrition influences mood, cognition, and emotional regulation. Evidence shows that dysbiosis and altered vagal signaling can reshape neuroanatomical structures and influence stress responses, challenging the traditional view of the mind as confined to the brain. The discussion also covers glioblastoma, a primary brain tumor that highlights the physical vulnerability of the mind. As the tumor infiltrates glial networks and disrupts cortical structure, patients experience significant changes in personality, memory, and emotional stability, showing that identity and agency depend on neural integrity. Clinical observations, particularly in nursing contexts, reinforce this systemic view. In both psychiatric and neuro-oncology settings, nurses play an important role in monitoring nutritional status, emotional resilience, and cognitive decline among patients, often serving as mediators between biological processes and psychological outcomes. Nursing interventions targeting diet, inflammation, and neurodegeneration have shown promise in improving treatment adherence and quality of life, further supporting the concept that distributed physiological networks shape mental health.

Key Words: mind-body problem, gut-brain axis, microbiota, glioma, nursing

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Introduction

The mind–body problem has long been a central issue in philosophy of mind, questioning how mental phenomena (such as consciousness, intentionality, and emotion) relate to the physical body and brain (Nagel, 1993).

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Classical ideas like Cartesian dualism, created by René Descartes, claim a separation between the immaterial mind (*res cogitans*) and the physical body (*res extensa*), leading to ongoing debates about how they interact cause-effect, their consistency, and what the self truly is (Alanen, 1989). Over time, new perspectives have developed to tackle the issues of dualism.

Physicalism, also named Reductive Materialism, claims that mental states are identical to brain states, meaning that every thought, emotion, or conscious experience aligns with specific neural processes (Crane, 2025). From this viewpoint, all mental phenomena can, in theory, be fully explained through neuroscience, neurochemistry, and brain physiology (Crane, 2025). Physicalism promotes a naturalistic and scientific approach to the mind, rejecting the need for immaterial substances, but it faces criticism for its difficulty in explaining the qualitative, subjective aspect of experience, what it feels like to be conscious (Crane, 2025).

Property dualism, also called Nonreductive Physicalism, which includes Searle's biological naturalism, suggests that mental phenomena are higher-level features generated by neurobiological mechanisms (Morris, 2018). Although these phenomena depend on the brain for their existence, they are not reducible to neural activity alone, in other words, consciousness, thoughts, and emotions cannot be fully explained just by mapping neurons or synaptic firing patterns, as they have emergent properties that come from, but go beyond the physical substrate (Morris, 2018). This view maintains the causal effectiveness of mental states, allowing them to influence behavior, while upholding a naturalistic framework that avoids invoking immaterial substances (Morris, 2018).

Finally, embodied and enactive cognition challenge the traditional view that the mind is confined to the brain, including the concept known as 4Es (embodied, embedded, extended, and enactive cognition), arguing that cognition is not limited to neural processes alone (Gallagher, 2023). Instead, mental activity arises through the dynamic interactions among the brain, body, and environment, encompassing perception, action, and social engagement (Gallagher, 2023). This perspective breaks down rigid divisions between "mind" and "body," emphasizing that our thoughts, emotions, and decisions are deeply rooted in and influenced by our physical actions, sensory experiences, and the world around us (Gallagher, 2023). In this view, understanding the mind requires looking beyond the brain to the entire organism within its environment, highlighting the distributed and interactive nature of cognition (Gallagher, 2023).

These premises serve as the core assumptions that define the conceptual boundaries of the mind–body debate, offering a basis for understanding and critiquing the claims made by each philosophical stance:

- **Dualism:** mind and body are fundamentally distinct.
- **Physicalism (Reductive Materialism):** the mind is just the brain itself.
- **Property Dualism / Non-reductive Physicalism:** mind emerges from brain processes but isn't reducible to them.
- **Embodied / Enactive Cognition:** mind isn't brain-bound at all but distributed across brain–body–environment.

Gut-brain axis

The gut–brain axis is a complex, bidirectional communication network linking the gastrointestinal (GI) tract and the central nervous system (CNS). It integrates neural, immune, and microbial signals, allowing the gut to influence brain functioning and behavior (Rosas-Sánchez *et al.*, 2025) (Figure 1).

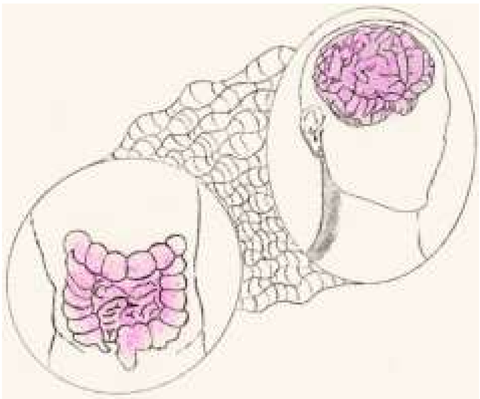

Figure 1. Artistic illustration of the Gut-brain axis.

At the neural level, the vagus nerve (cranial nerve X) acts as the primary conduit for communication between the gut and brain, transmitting sensory information about the digestive system's state directly to the brain, for regions such as the amygdala and prefrontal cortex, regions involved in emotional regulation (Mhanna *et al.*, 2024; Rosas-Sánchez *et al.*, 2025). Supporting this is part of the autonomic nervous system (ANS), the enteric nervous system (ENS), sometimes called the "second brain", which contains millions of neurons embedded in the gut wall (Rosas-Sánchez *et al.*, 2025). While capable of operating independently to control digestion, the ENS also constantly communicates with the CNS, transmitting responses ranging from appetite to stress (Rosas-Sánchez *et al.*, 2025).

The gut epithelium forms a critical barrier between the internal environment and the external world, regulating nutrient absorption and immune surveillance (Vancamelbeke and Vermeire, 2017). Specialized enteroendocrine cells within the gut lining release hormones like cholecystokinin (CCK), peptide YY (PYY), and glucagon-like peptide-1 (GLP-1), which mainly influence satiety, mood, and cognitive function by acting on receptors in the brain (Rosas-Sánchez *et al.*, 2025).

The gut also contains immune cells, which interact with neural circuits via cytokine signaling, communicating with the gut's microbiota, including bacteria, viruses, and fungi, that play an essential role in modulating the CNS through immunological responses (Mhanna *et al.*, 2024; Rosas-Sánchez *et al.*, 2025). These microbes metabolize food into bioactive compounds such as short-chain fatty acids (SCFAs), such as butyrate, propionate, and acetate, which can either directly cross into circulation and alter brain signaling through microglia and astrocyte phenotype or indirectly through contact with dendritic cells and regulatory T cells, which in turn shape neuroinflammatory responses (Mhanna *et al.*, 2024). Shifts in microbial composition have been correlated with changes in mood, cognition, and resilience to stress (Rosas-Sánchez *et al.*, 2025).

Taken together, these mechanisms reveal that the gut is far more than a digestive organ. Through a complex web of neural, immune, and microbial pathways, it acts as an active partner in regulating brain function and behavior, reshaping our understanding of the biological foundations of the mind.

Psychological, Cognitive & Structural Dimensions

The gut–brain axis does more than regulate digestion and immune function, it actively shapes mental states and cognitive processes, highlighting the intricate interplay between bodily systems and the mind (Lee et al., 2025). Alterations in gut microbiota composition, known as dysbiosis, have been linked to anxiety, depression, and stress-related disorders (Mhanna *et al.*, 2024).

For instance, patients with major depressive disorder (MDD) often exhibit reduced microbial diversity, such as decreased levels of *Lactobacillus* and *Bifidobacterium*, *Faecalibacterium*, *Coprococcus*, and *Roseburia*, all of which produce anti-inflammatory metabolites such as SCFAs (Jach *et al.*, 2023). In contrast, potentially pro-inflammatory taxa, such as *Alistipes*, *Eggerthella*, *Oscillibacter*, and *Desulfovibrio* are often increased, correlating with the severity of depressive symptoms (Jach *et al.*, 2023). In a study by Ye et al. (2025), alterations in the gut microbiota were associated with distinct mental health outcomes (Ye *et al.*, 2025). For instance, increased exposure to *Alphaproteobacteria*, *Burkholderiales*, *Eisenbergiella*, *Marvinbryantia*, *Lachnospiraceae* NC2004, and *Proteobacteria* was linked to a higher risk of developing anorexia nervosa (AN) (Ye *et al.*, 2025). Similarly, the presence of *Eubacterium oxidoreducens* group, *Gordonibacter*, *Parabacteroides*, and *Betaproteobacteria* was correlated with schizophrenia, while members of the genus *Dorea* were found to influence anxiety disorders (AD) (Ye *et al.*, 2025). These findings reinforce the hypothesis that microbial composition may play a disorder-specific role in the gut–brain axis (Ye *et al.*, 2025).

Many gut microbes synthesize or modulate neurotransmitters, including serotonin, GABA, and dopamine, thereby altering neural signaling patterns that shape emotions, reward, and cognitive flexibility (Mhanna *et al.*, 2024). For instance, *Escherichia* and *Enterococcus* species can produce serotonin, which in turn influences enterochromaffin cell signaling via negative feedback (Mhanna *et al.*, 2024). Enterochromaffin cells produce the majority of the body's serotonin, which indirectly influences central serotonergic signaling through the vagus nerve (Mhanna *et al.*, 2024). A disruption in *Escherichia* and *Enterococcus* colonies may decrease serotonergic neuron activation, decreasing the feeling of happiness and emotional stability associated with depression like behavior (Mhanna *et al.*, 2024).

To provide further context, Lee et al. (2025) demonstrated that the gut microbiota significantly influences early stages of brain development, including the maturation of critical components such as the blood–brain barrier and the hypothalamic–pituitary–adrenal (HPA) axis (Lee et al., 2025). Building on this, Ye et al. (2025) advanced the understanding of the bidirectional relationship between gut microbiota and psychiatric disorders, reinforcing the view that microbial composition may serve as an etiological factor in mental health (Ye *et al.*, 2025). One proposed mechanism involves microbiota-driven alterations in neuroanatomy (Ye *et al.*, 2025). For example, increased exposure to *Alphaproteobacteria* has been linked to anorexia nervosa (AN) through microstructural changes in the left cingulum of the hippocampus, a brain region involved in emotional regulation and body image processing (Ye *et al.*, 2025). Similarly, greater proliferation of the genus *Dorea* has been linked to anxiety disorders (AD) by contributing to volumetric increases in the right cerebellar cortex, thereby slightly elevating the risk of AD (Ye *et al.*, 2025). Neuroanatomical alterations may therefore serve as intermediaries, linking microbial composition to psychiatric outcomes (Ye *et al.*, 2025). While this evidence is still emerging, it highlights the potential for future clinical strategies targeting gut health as a means of improving mental health.

Additionally, altered vagal signaling due to microbial changes can dysregulate the HPA axis, leading to exaggerated stress responses characteristic of anxiety and depression (Rosas-Sánchez *et al.*, 2025). Immunologically, dysbiosis may also shift cytokine profiles toward a pro-inflammatory state, increasing IL-6, TNF-α, and CRP, which can overstimulate the HPA axis, leading to increased cortisol production and contributing to mood disturbances (Rosas-Sánchez *et al.*, 2025).

These findings suggest that psychiatric disorders, once considered purely psychological, can induce measurable changes in brain structure, neuroanatomy, and peripheral signaling. The mind, in this view, is not merely emergent from the brain but is continuously shaped by systemic biological processes. Yet if microbial dysbiosis and vagal modulation can subtly reshape cognition and emotion, what happens when the brain itself is structurally dismantled?

An example is Gliomas. Gliomas are a diverse group of primary brain tumors originating from the central nervous system (CNS) (Louis *et al.*, 2021). The 2021 World Health Organization (WHO) classification integrates histological and molecular features, refining glioma subtypes to enhance diagnostic accuracy and prognostic precision. Specifically, diffuse gliomas arise from glial cells derived from neural stem cells, glial progenitors, including oligodendrocyte precursor cells and astrocytes, refining glioma categorization to improve diagnosis and prognosis (Louis *et al.*, 2021). They vary in aggressiveness, molecular characteristics, and response to treatment, making classification essential for guiding therapeutic strategies (Louis *et al.*, 2021).

Recent studies have highlighted the significant influence and importance of the gut microbiota on glioma progression and tumor immune microenvironment, suggesting that Glioma growth may deplete key gut metabolites, thereby disrupting the gut-brain axis (D’Alessandro *et al.*, 2020). For instance, alterations in gut microbiota can modulate glioma growth and impact innate immune cells involved in tumor immunosurveillance in mice, suggesting a crucial gut-brain-tumor axis in glioma pathology (D’Alessandro *et al.*, 2020). Furthermore, antibiotic-induced gut dysbiosis promoted vasculogenesis within the tumor microenvironment, as evidenced by increased expression of endothelial markers and enhanced vessel formation in glioma tissue, suggesting that microbial metabolites may influence glioma progression not only through immune modulation but also by shaping the tumor's vascular architecture, an essential factor in tumor growth, invasion, and treatment resistance (Rosito *et al.*, 2024).

These pathways show, as once reiterated, how changes in microbes can affect not only mood and anxiety through systemic and central inflammation but reshape structures and neuroanatomy, directly influencing the the mind–body problem. If mental states like mood and anxiety are influenced not only by the brain but also by gut microbes and immune activity, then the traditional view of the mind as confined to the brain becomes incomplete. Cognitive and emotional experiences arise from distributed physiological networks, indicating a more embodied, integrated view of the self. Instead of being purely neural, mental states depend on the interconnectedness of brain, body, and microbiota, challenging strict dualist or solely brain-centered physicalist views. This perspective is even more supported when considering neurological diseases such as glioblastoma, where damage to brain tissue causes significant changes in cognition, emotion, and identity (Liu *et al.*, 2025). As the tumor infiltrates glial networks and disrupts cortical structure, patients often experience personality shifts, memory loss, and emotional flattening, not as psychological side effects, but as results of physical deterioration (Louis *et al.*, 2021; Liu *et al.*, 2025). Such cases highlight that the mind is not just influenced by bodily systems, it depends on them, biologically rooted in the health of neural tissues.

Ethical & Practical Implications

Clinical observations consistently highlight the interaction between nutrition and mental health, supporting emerging research on the gut–brain axis. For example, in perinatal populations, unhealthy dietary habits have been associated with low motivation to adopt lifestyle changes, reduced maternal well-being, and more apathetic attitudes toward pregnancy (Leung and Kaplan, 2009). These findings are consistent with evidence linking poor maternal nutrition to adverse mood outcomes and diminished engagement in prenatal care (Leung and Kaplan, 2009).

In psychiatric inpatient settings, nutritional status is also a central focus of nursing interventions (Panchal *et al.*, 2025). Patients with balanced diets and more positive attitudes toward food frequently demonstrate greater motivation, more optimistic outlooks regarding their illness, and stronger adherence to treatment plans (Panchal *et al.*, 2025). This aligns with growing evidence suggesting that nutritional interventions can improve mental health outcomes and quality of life in psychiatric populations (Firth *et al.*, 2020).

Taken together, these patterns suggest a feedback loop in which nutrition and mental health continuously influence one another, poor nutrition exacerbates psychiatric symptoms, while improved dietary support may enhance psychological resilience and treatment engagement (Firth *et al.*, 2020).

These patterns also reflect a broader clinical reality, nurses increasingly recognize the biological underpinnings of mental health and the importance of systemic factors such as neurodegeneration (Levenson et al., 2014). In gut–brain axis–related disorders, nursing interventions that incorporate dietary education, probiotic support, and stress reduction strategies have shown promise in improving mood and treatment adherence (Manoj and Bautisa, 2025). This shift toward integrative care acknowledges that mental health is not isolated within the brain but emerges from a network of physiological interactions.

Similarly, in neuro-oncology settings, nurses caring for patients with glioblastoma must navigate the intersection of cognitive decline, emotional dysregulation, and physical deterioration. As the tumor disrupts glial networks and cortical architecture, patients often exhibit personality changes, memory loss, and emotional flattening, and even the posterior development of depression and anxiety as a clinical phenomenon that nurses are uniquely positioned to observe and manage (Liu *et al.*, 2025). Cognitive behavioral therapy and cognitive remediation, when integrated into nursing care plans, have been shown to improve psychological well-being and quality of life in glioma patients undergoing chemotherapy (Liu *et al.*, 2025).

Taken together, these insights reinforce the need for nursing models that treat mental health as biologically embedded, responsive not only to pharmacological interventions but also to nutritional, microbial, and structural factors. This approach aligns with emerging research and clinical practice, positioning nurses as key mediators between body and mind.

Conclusion

The evidence presented throughout this article challenges the traditional notion of the mind as a purely cerebral phenomenon. From the subtle influence of gut microbiota on mood and cognition to the devastating impact of glioblastoma on identity and agency, it becomes clear that mental states are biologically embedded and systemically mediated. The gut–brain axis reveals how peripheral systems, nutrition, immune activity, and microbial composition can shape emotional and cognitive experiences, while glioblastoma exposes the fragility of those experiences when the brain's structural integrity is compromised.

Clinical observations, particularly in nursing practice, reinforce this embodied view of the mind. Nurses routinely witness how dietary interventions, microbial health, and neurodegeneration affect patient motivation, emotional resilience, and treatment engagement. Their role at the intersection of biology and behavior underscores the need for integrative care models that treat mental health as a systemic phenomenon, not isolated within the brain, but distributed across the body.

Taken together, these insights demand a rethinking of the mind–body problem. The self is not housed in the brain alone, nor is it separable from the biological processes that sustain it. Instead, cognition, emotion, and identity emerge from a dynamic interplay between neural architecture, bodily systems, and environmental inputs. This view resists both strict dualism and reductive physicalism, offering a more nuanced, biologically grounded conception of the mind, one that is vulnerable, relational, and deeply embodied.

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