EDITORIAL

The Gut and Behavior

Rajshree R Gupta[1], Navpreet Mann[2]

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A microbiome is defined as an assemblage or community of various microorganisms living together. So does the microbiome of the human gut, but until recently, there wasn't much research on what are the effects of these on the host itself. Numerous studies have documented the potential impact the microbiome has on the behavior and cognitive abilities of the host.[1]

Research shows that during the developmental period in infancy, the microbiome influences the growth of the brain.[2] Most of the evidence as to what the mechanism of action of microbiota on the brain causing changes in behavior is recorded by studies done on animals. Germ-free (GF) mice are the most commonly used animals in determining the influence of microbiota on behavior. The GF mouse model was first used in 1957.

A change in behavior was observed when healthy rodents were given probiotics. In a study spanning 28 days, the administration of probiotics to mice resulted in reduced anxiety-like and reduced depressive-like behavior. Others, too, have reported a significant reduction in anxiety-related behavior. When a combination of probiotics was given to healthy human subjects even, they showed a beneficial effect on anxiety and depression measures,[3] reductions in sad mood triggered by a psychological stimulus. A reduction in depression anxiety and stress scales by modulating the hypothalamic pituitary adrenal axis in petrochemical workers has been documented.[6]

The mechanism of production of these results has been documented *via* the immune system to some extent. However, the microbiota, gut, and brain may communicate by nonimmune mediated mechanisms as well.[4] Microbial endocrinology is an amalgamation of fields of microbiology and neurophysiology. It has been suggested that neurochemicals produced by the host during periods of stress, such as the biogenic amine norepinephrine, could dramatically increase the growth of bacteria both *in vitro* and *in vivo*). Since bacteria, too, produce neuroendocrine hormones and other neuroactive compounds, most likely, these products produced internally affect neural receptors within the gut or extraintestinal neuronal sites. There is an abundance of literature to support the fact that microbiome does affect behavior in both human and animal model systems.[3,5]

Much of the research and data has been collected by doing preclinical studies. But with the advent of newer technology and growing interest in the field shift to more human studies has begun. Changes in the microbiota-gut-brain axis have been reportedly held responsible for conditions such as functional gastrointestinal (GI) disorders, inflammatory bowel diseases, obesity, and metabolic syndrome.[6] In addition to these, non-GI brain disorders include anxiety and depression, multiple sclerosis, Alzheimer's disease, Parkinson's disease, and autism.[7] An innovative approach to confirm this association is by combining manipulations of the gut microbiota with brain imaging and measures of symptoms of emotion. Probiotic ingestion has been known to affect brain function in healthy women.[8]

Another area of interest is the use of microbiome in autism spectrum disorder (ASD). It is a neurological disorder that affects normal brain development. The bidirectional connection between the gut and brain is one of the factors influencing the development of this condition. Most of the autistic patients suffer from GI symptoms. Microbial fermentation of plant-based fiber can produce different types of short-chain fatty acid that may have a beneficial or detrimental effect on the gut and neurological development of autistic patients. Several comprehensive studies of the gut microbiome and microbiota-gut-brain axis help to understand the mechanism that leads to the onset of neurological disorders and find possible treatments for autism.[9]

Whenever the homeostasis of the gut is haywire, there is a production of oxidative stress which in turn affects the neuronal cells and neurotransmitters. This becomes the pathophysiology of neurodevelopmental disorders. Research has confirmed a difference in the constitution of gut bacteria among ASD cases and healthy controls. As discussed, data from animal models of ASD have shown an altered gut microbiome and its association with abnormal metabolite profile and altered behavior phenotype. The reason can be an abnormal neurochemical production in the gut microbiome, which leads to changes in the immune system, especially in ASD.[10]

The paucity of data and strenuous research leads to a few challenges. The mechanism of action of microbiota on brain affection is one area of concern. No conclusive evidence of a microbial endocrinology-based mechanism that can account for the changes in behavior has been documented yet. Specific receptors for binding within the gut or extraintestinal site must be demonstrated for the specific neurochemical produced by the microorganism.

Also, what are the individual components of bacteria that mediate the effects need to be demystified. Metabolomics can be of help for our better understanding of the signaling cascades and roles of bacterial products. Lastly, as most of the data is based on studies conducted on rodents, more human studies should be done.

[1,2]Department of Physiology, Army College of Medical Sciences, Delhi, India

Corresponding Author: Navpreet Mann, Department of Physiology, Army College of Medical Sciences, Delhi, India, Phone: +91 9999652844, e-mail: drnavpreet.vmmc@gmail.com

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Studies have reported the changed composition of the microbiota in depression and autism, schizophrenia, anxiety, drug addiction, and eating disorders.

Orcid

Navpreet Mann https://orcid.org/0000-0002-0627-5289

References

1. Cryan JF, Dinan TG. Mind-altering microorganisms: the impact of the gut microbiota on brain and behaviour. Nat Rev Neurosci 2012;13(10):701–712. DOI: 10.1038/nrn3346
2. Douglas-Escobar M, Elliott E, Neu J. Effect of intestinal microbial ecology on the developing brain. JAMA Pediatr 2013;167(4):374–379. DOI: 10.1001/jamapediatrics.2013.497
3. Messaoudi M, Lalonde R, Violle N, et al. Assessment of psychotropic-like properties of a probiotic formulation (Lactobacillus helveticus R0052 and Bifidobacterium longum R0175) in rats and human subjects. Br J Nutr 2011;105(5):755–764. DOI: 10.1017/S0007114510004319
4. Lyte M. Microbial endocrinology in the microbiome-gut-brain axis: how bacterial production and utilization of neurochemicals influence behavior. PLoS Pathog 2013;9(11):e1003726. DOI: 10.1371/journal.ppat.1003726
5. Collins SM, Kassam Z, Bercik P. The adoptive transfer of behavioral phenotype via the intestinal microbiota: experimental evidence and clinical implications. Curr Opin Microbiol 2013;16(3):240–245. DOI: 10.1016/j.mib.2013.06.004
6. Yau PL, Castro MG, Tagani A, et al. Obesity and metabolic syndrome and functional and structural brain impairments in adolescence. Pediatrics 2012;130(4):e856–e864. DOI: 10.1542/peds.2012-0324
7. Scheperjans F, Aho V, Pereira PA, et al. Gut microbiota are related to Parkinson's disease and clinical phenotype. Mov Disord 2015;30(3):350–358. DOI: 10.1002/mds.26069
8. Tillisch K, Labus J, Kilpatrick L, et al. Consumption of fermented milk product with probiotic modulates brain activity. Gastroenterology 2013;144(7):1394–1401. DOI: 10.1053/j.gastro.2013.02.043
9. Taniya MA, Chung HJ, Al Mamun A, et al. Role of gut microbiome in autism spectrum disorder and its therapeutic regulation. Front Cell Infect Microbiol 2022;12:915701. DOI: 10.3389/fcimb.2022.915701
10. Vellingiri B, Aishwarya SY, Benita Jancy S, et al. An anxious relationship between autism spectrum disorder and gut microbiota: a tangled chemistry? J Clin Neurosci 2022;99:169–189. DOI: 10.1016/j.jocn.2022.03.003