

LINGUISTICALLY, THE term bowel has been used to express the inner workings, the depths of man emotionally as well as physically. It is where input is broken down, digested, absorbed, sorted, reacted to, and transformed into us.

Interestingly enough, while seeking to better understand the connection between the bowels of our gut and the bowels of our mind I found an indisputable link that has been termed the Microbiota Gut Brain Axis (MGB axis). Let's break that term down.

Inhabiting our gut are billions of microorganisms. In fact, there are more of them than there are of us, cellularly speaking. The sheer quantity of microorganisms inhabiting the human body is enormous. Within a single sample can be found more than 1000 different species. This population is the microbiota, our microbiome.

An axis is typically thought of as a line on which significance hinges. It can be a line of direction, motion, growth, a point or continuum on which something centers. As we

will see, this line of direction is a two-way street running from the brain to the gut and vice versa.

"The proposal of a MGB axis suggests that through a dynamic alignment, microbiota inhabiting the intestinal lumen affects its host's CNS (central nervous system) activity (including vegetative and cognitive functions), and *vice versa*. Brain activity impacts microbiota development and composition."¹

The process of passing through the vaginal canal upon being birthed and the ensuing breastfeeding provides the initial inoculation of the newborn. From 1990-2008, the rate of cesarean sections doubled, making one-third of US births a surgical procedure. There is concern as to how and to what extent the bypassing of the inoculation process in a normal delivery impacts the infant. Seeking to better understand the impact of C-sections on the acquirement and development of the microbiome, Canadian researchers compared infants who were born vaginally or surgically and were breastfed or formula fed. It

was found that at four months of age, surgically born babies had

significantly less *Bacteroides* and *Escherichia-Shigella* species while formula-fed babies had overrepresentation of *Clostridium difficile*, *Peptostreptococcaceae*, and *Verrucomicrobiaceae*. "Infants born by elective cesarean delivery had particularly low bacterial richness and diversity."²

Over time the gut develops a diverse and distinct brew of bacterial species determined in part by genetics, by what bacteria live in and on individuals around us, as well as by the diet. The strains of bacteria, fungi, and their various proportions in the gut are as unique to us as our fingerprint.

Not only can an individual's microbiome be affected by exposure to microbes, but research is also pursuing the impact made by the exposure to emotion. Studies have shown that psychological stress suppresses beneficial bacteria, such as *Lactobacilli*, as we will see.

Integrative immunologist Michael Bailey and colleagues "found that infant monkeys whose mothers had been startled by loud noises during pregnancy had fewer *Lactobacilli* and *Bifidobacteria*. In 2008, researchers led by psychologist Simon Knowles, PhD, of Swinburne University of Technology in Australia found similar results in humans. During exam week, university students' stool samples contained fewer *Lactobacilli* than they had during the relatively untroubled first days of the semester."³ When mice shared a cage with aggressive mice beneficial bacteria diminished, this "decreased the overall diversity of the gut microbiome, and promoted the overgrowth of harmful bacteria, making animals more susceptible to infection and causing inflammation in the gut."⁴



The mind's effect upon our gastrointestinal tract is familiar to us. We know what it is like to have butterflies in our stomach. The gut's effect on the brain however, is just emerging into public awareness. In neuroimmunologist, John Bienenstock's words, "The idea that bacteria teeming in the gut—collectively known as the microbiome—can affect not only the gut, but also the mind, 'has just catapulted onto the scene.'"⁵ While the majority of research has been conducted in animals, it remains quite

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fascinating. Researchers have been able to alter the brain chemistry of rodents simply by tweaking the balance between beneficial and disease-causing bacteria in the animal's guts. Neural development, emotional behavior, pain perception, and even brain chemistry are affected by the microbiota. Gut bacteria have even been boldly referred to as mind-altering microorganisms. Gut bacteria "produce hundreds of neurochemicals that the brain uses to regulate basic physiological processes as well as mental processes such as learning, memory and mood."⁶

When timid mice were given antibiotics, which altered their microbiome, they became bold. Their behavior changed. Beneficial bacteria given to anxiety-prone mice calmed them down. A broth laced with *Lactobacillus rhamnosus*, considered a beneficial probiotic, was given to a group of mice while a control group just got broth. After 28 days, the researchers ran the mice through a battery of tests to detect signs of anxiety or depression. "Compared with mice in the control group, those fed *Lactobacillus* were

more willing to enter exposed areas of a maze, and also less likely to give up and just start floating when subjected to a 'forced-swim' test—a test that serves as a mouse analog of some aspects of human depression. The probiotic diet also blunted animals' physiological responses to the stress of the forced-swim test, causing them to produce lower levels of a measured stress hormone. And in the mice fed *Lactobacillus*, some brain regions showed an increase in the number of receptors for gamma-aminobutyric acid, or GABA—a neurotransmitter that mutes neuronal activity, keeping anxiety in check."⁷

Dr. Emeran Mayer, Professor of Medicine and Psychiatry at University of California, Los Angeles, also believes that gut microbes affect what goes on in the brain. His research with humans has involved looking at the MRI scans of the brains of thousands of volunteers and then comparing them with the bacterial composition of their gut. Amazingly he found that "the connections between brain regions differed depending on which species of bacteria dominated a person's gut."⁸

The idea that administering probiotics, a supplemental form of beneficial microbes, might be used therapeutically is intriguing. In Baltimore, probiotics are being tested to see if supplementation can help prevent relapses of mania among patients suffering from bipolar disorder. Others are scanning brains after probiotic ingestion and finding subtle signs that the brain circuits involved in anxiety become less reactive.

Researchers emphasize that they are just in the early stages of research and that a lot more work needs to be done to understand the mysteries of the bowel.

Scripture speaks of bowels being refreshed. "For we have great joy and consolation in thy love, because the bowels of the saints are refreshed by

thee . . . Yea, brother, let me have joy of thee in the Lord; refresh my bowels in the Lord" (Philemon 7, 20). I like the sounds of bowels being refreshed, rebooted, and rejuvenated. Perhaps inspiration understands the connection between the bowels and is giving us hope.

¹ A. Montiel-Castro, Rina Gonzalez-Cervantes, G. Bravo-Ruiseco, G. Pacheco-López, "The microbiota-gut brain axis: neurobehavioral correlates, health and sociality," *Front Integ Neurosci*, Oct. 7, 2013, www.ncbi.nlm.nih.gov/pmc/articles/PMC3791857/.

² MB Azad, T. Konya, H. Maughan, DS Guttman, CJ Field, RS Chari, MR Sears, AB Becker, JA Scott, AL Kozyrskyj, "Gut microbiota of healthy Canadian infants: profiles by mode of delivery and infant diet at 4 months," *Pub Med. gov*, March, 19, 2013, <http://www.ncbi.nlm.nih.gov/pubmed/?term=Infants+born+by+elective+cesarean+delivery+had+particularly+low+bacterial+richness+and+diversity>

³ Siri Carpenter, "That gut feeling," *American Psychological Association*, Sept. 2012, www.apa.org/monitor/2012/09/gut-feeling.aspx.

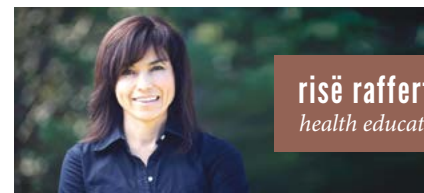
⁴ Ibid.

⁵ Ibid.

⁶ Ibid.

⁷ Ibid.

⁸ Rob Stein, "Gut Bacteria Might Guide The Workings Of Our Minds," *NPR*, Nov. 18, 2013, www.npr.org/blogs/health/2013/11/18/244526773/gut-bacteria-might-guide-the-workings-of-our-minds.



Risë has been writing on various health subjects for over 20 years. She has inspired many through her research and down-to-earth writing and speaking style. She believes that healthy living is intimately tied to happiness and wholeness.