It’s All In Your Gut: The Microbiota–Mental Health Connection

For thousands of years Ayurveda has emphasized the critical nature of digestion and its impact on the entire health of the organism. Modern science is starting to catch on to this connection, with the emergence of compelling research on the connection between gut health and mental health. Studies are now making it into the mainstream.

In October 2014 there was a story on NPR entitled “Gut Bacteria Might Guide the Workings of Our Minds.” In the news report Rob Stein says “There’s growing evidence that gut bacteria really might influence our minds.”¹ Dr. Emeran Mayer, a professor of medicine and psychiatry at UCLA, discusses recent research in which he conducted MRI scans on thousands of volunteers and then compared their gut microbe makeup to their brain structure. In sixty of those volunteers he found a distinct correlation between how areas of the brain connect and the type of bacteria dominant in their gut. The bacteria in our guts may influence the circuitry in our brains.¹

Additionally, researchers at McMaster University, in Ontario, conducted studies on mice in which they altered their gut environments and observed whether the change in gut bacteria influenced characteristics such as boldness, timidity, and aggression. The findings were compelling: researchers observed that when timid, anxious mice were given the gut bacteria of fearless mice they became less anxious and timid.¹
These and similar findings have inspired a team of researchers in Baltimore to experiment with using probiotics to treat mental and mood disorders in humans. Faith Dickerson, director of psychology at Sheppard Pratt Health System, says “The idea is that these probiotic treatments may alter what we call the microbiome and then may contribute to an improvement of psychiatric symptoms.”¹ To date the efficacy of probiotic treatments as a remedy for mental and mood disorders is inconclusive, at least amongst this set of researchers. However, there is anecdotal evidence as well as other scientific research which suggests that altering the gut microbiome positively impacts mental health.

Though this type of research may seem merely trendy, in light of the booming popularity in probiotic drinks and supplements, scientists in the U.S. have been tinkering with probiotics as a cure for mental health maladies for a century or more.

Broadly speaking, ours was certainly not a new theory; it was, rather, a scientifically refined revival of select assertions that had been made a century prior. At our time of revival, in the early 2000s, the contention that the intestinal microbiota and the microbial–influenced integrity of the intestinal lining are of relevance to mental health disorders was, if it were to be suggested at all, a notion of nostalgia (Bested, Logan, & Selhub, 2013).²
In the early 1900s a number of high-profile physicians and scientists were interested in how undesirable bacteria in the colon could influence fatigue, melancholia, and neurosis. At that time the idea of “autointoxication” was a popular concept among researchers and physicians: “The terms autointoxication, intestinal stasis, and intestinal toxemia were often used interchangeably to describe a process whereby intestinally-derived toxins could influence systemic health” (Bested, Logan, & Selhub, 2013). Some scientists of this bent recommended drastic and aggressive measures, such as removal of portions of the colon. On the other hand, others advocated for the internal ingestion of specific friendly bacteria via sources such as lactic acid drinks, probiotic pills, and dairy-based beverages. “By 1905, there was a growing acceptance of autointoxication among some ranks of psychiatrists, mental hospital superintendents, and other physicians” (Bested, Logan, & Selhub, 2013).

Unfortunately, physicians who bought into autotoxemia theories performed many unnecessary surgeries such as colectomies and removal of tonsils and teeth, which later caused such practices and their underlying theories to be dismissed as pseudo-scientific charlatanry. Far less invasively, proponents of autotoxemia theory spurred a commercial boom in products such as “acidophilus milk,” which made its way into mainstream commercial advertising during the 1930s. For some, commercial and monetary gains may
have been at the root of endorsing probiotic cures to treat systemic issues. However, as suggested by Bested, Logan, and Selhub, although the resulting practices of autotoxemia theory were amiss and even inhumane at times, there was a grain of truth to these theories, since “modern research continues to show strong associations between microbial–induced periodontal disease, chronic low–grade inflammation, and higher risks of cardiovascular disease, diabetes, lung disease, and adverse pregnancy outcomes”. If our gut microbiota can impact overall systemic health, it follows that what’s in our gut may have a big impact on the nervous system and mental health as well.

During the early 1900s, in addition to recommending the oral intake of L. acidophilus, physicians also experimented with administering probiotics via colonic irrigation, as well as subcutaneous fecal vaccines. Of course, the practice of colonic irrigation is nothing new. “Greek Historian Herodotus reported that the ancient Egyptians used enemas three days per month along the lunar cycle because they are convinced that all the diseases incident to man have their origin in the food that he takes” (Bested, Logan, & Selhub, 2013). Likewise, in vol. VI, chapter 1, verses 27–28 of Bhagwan Dash’s translation of the Charaka Samhita, the value of niruha basti (cleansing enema) is emphasized. Niruha basti is proclaimed to slow the aging process, to promote happiness, longevity, strength, voice, complexion, and more.

In Vagbhata’s Astanga Hrdayam, drinking oils and giving purgatives to clear the channels of digestion is recommended as a treatment for insanity: “In
insanity caused by vata, drinking of oil (internal oleation therapy) should be administered first; if there is obstruction of the channels, mild purgatives mixed with fats should be given” (vol. I, verses 18–20). The rishis drew a clear connection between mental imbalance and obstruction of the bowels. According to Ayurveda, obstruction of the downward flow of energy and the inhibition of regular elimination leads to a number of health issues. The presence of good bacteria and excretion of toxins contributes to a healthy digestive system and likely a healthy mind.

Turn-of-the-century autotoxemia theorists would have agreed. A small number of physicians claimed success with colonic irrigation, including relief from anxiety and depression as a result of injecting isolate coliforms from fecal bacteria. However, these methods were not well-tested enough at the time to claim scientific validity, so the movement died out for decades. Fortunately, research into the importance of the gut microbiome has made a comeback. In 2003 it was suggested in a scientific journal that treatment with probiotics may be helpful in treating depression and fatigue. Similarly, in 2012 a leading journal of psychiatry stated that “there has been an accumulation of data from both clinical and preclinical studies supporting the view that probiotics may have a role in the treatment of depression.”

One study that corroborates the importance of the gut–mental health connection was performed in England a little more than a decade ago. In this study researchers analyzed hospital database records to determine whether or
not depression or anxiety co-occurs with ulcerative colitis and Crohn’s disease more than expected by chance. The findings were positive: “Both depression and anxiety preceded ulcerative colitis significantly more often than would be predicted from the control population’s experience” (Kurina et al., 2001). Patients with Crohn’s disease did not appear to have higher incidences of depression and anxiety preceding diagnosis of Crohn’s disease. However, those same mood disorders were reported higher than expected in patients after the diagnosis of Crohn’s. In this case it is hard to tell which condition is causal: anxiety/depression or the gastrointestinal tract disorders. It is interesting to note that “The strongest association between either anxiety or depression and ulcerative colitis occurred when the diagnoses were separated by less than one year” (Kurina et al., 2001). Patients may have developed depression and anxiety simply as a result of living with ulcerative colitis or Crohn’s disease. Another possibility is that depression and anxiety were present as a result of developing Crohn’s disease or ulcerative colitis, and that the two conditions were diagnosed together when the patient was admitted to the hospital for Crohn’s disease or ulcerative colitis. Either way, these findings again point to a potentially strong relationship between the health of our GI tract and the health of our moods and minds.

The notion that gut health correlates with mental health supports longstanding Ayurvedic teachings that emphasize the importance of digestion and proper diet as the basis of all sound health. According to the Charaka
Samhita, vol. I, ch. VI, verse 3, “The strength and lustre of one who knows the suitable diet and regimen for every season and practices accordingly are enhanced.”

Bhagwan Dash further elucidates: “Enhancement of strength and lustre includes happiness, etc. caused by the maintenance of the equilibrium of tissue elements.” And in vol. I, ch. XXVII, verse 342, we read that “Strength, health, longevity and vital breath are dependent upon the power of digestion including metabolism.”

Modern Ayurvedic practitioner Dr. David Frawley writes that “The condition of the stomach indicates the general state of Kapha in the body—our sense of contentment, nourishment, and happiness. It is like the mother of the rest of the body. The stomach is a sensitive organ easily upset not only by wrong diet but also by emotional disturbance or worry” (Ayurvedic Healing, p. 141). And, the health of the colon is equally important: “As such [the colon] is perhaps the body’s most important organ of elimination, removing waste matter from the entire digestive tract. . . However, the stool. . . functions as the earth element in the body to ground us” (Ayurvedic Healing, p. 171). As Frawley describes so aptly, the health of our GI tract extends to the health of our bodies and minds as a whole. And, as noted in the Charaka Samhita, all of health is greatly dependent upon the health of digestion.

If we accept that there is likely a relationship between what’s in our gut and what’s in our mind, the next obvious questions are “What is the connection?” and “How do the two communicate?” It appears that the vagus
nerve may play a key role. The vagus nerve runs from the brain stem to the abdomen and is responsible for much of the bidirectional signaling that is crucial for gut–brain communication.

According to Montiel-Castro et al. (2013):

It has recently become evident that such microbiota, specifically within the gut, can greatly influence many psychological parameters. . . It is now evident that the bidirectional signaling between the gastrointestinal tract and the brain, mainly through the vagus nerve, the so called “microbiota–gut–vagus–brain axis” is vital for maintaining homeostasis and it may be also involved in the etiology of several metabolic and mental dysfunctions/disorders.”

In their review of findings, Montiel-Castro et al. point out that the specific microbiota that inhabit individuals may have an impact on whom they socialize and bond with. It appears that there is two-way communication between the gut and the central nervous system via this gut–brain–axis, for “evidence suggests that various forms of subliminal interoceptive inputs from the gut, including those generated by intestinal microbiota, may even influence memory formation, emotional arousal, affective behaviors and decision–making processes” (Montiel-Castro et al., 2013). Therefore, the specific microbiota in our GI tract influences not only our personal psycho–emotional state, but also how we relate to others. Furthermore, other members of our species may be
testing us out through interactions such as mouth to mouth contact to find out whether or not our particular blend of microbiota is beneficial and/or favorable to them.\(^6\)

In terms of the health of the individual, stress influences the gut microbiota. Stress signals the adrenals to release cortisol, which can alter gut permeability, affect immune cell activity and contribute to changes in gut microbiota. Coming at it from the other end, the intake of probiotics alters gut microbiota and may have a marked effect on brain function.\(^6\)

Research done by Bercik et al. (2012) corroborates this line of thought. In a study conducted on mice, they tested interactions between the vagus nerve, anxiety, colitis, and the probiotic bifidobacterium longum. The researchers found in prior studies that bifidobacterium longum effectively reduces colitis. It is evident that B. longum reduces the excitement of neurons in the GI tract.\(^7\)

However, Bercik et al. wanted to find out how gut neurons communicate with the central nervous system. They operated under the assumption that there is some communication between enteric neurons and the central nervous system because anxiety and depression are much more common in patients with chronic gut disorders, particularly inflammatory gut disorders.

Colitis was induced in mice by the administration of dextran sodium sulfate in their drinking water. A subdiaphragmatic vagotomy (severing of the vagus nerve) was performed on some of the mice and some mice were treated with bifidobacterium longum after colitis was induced. The key findings were
that “Chronic colitis was associated with anxiety–like behavior, which was absent in previously vagotomized mice.”⁷ Therefore, the role of the vagus nerve is pivotal. Strikingly, mice who had colitis only exhibited anxiety–like behavior when their vagus nerve was intact. Furthermore the B. longum decreased excitability of enteric neurons (nerves that govern the GI system) yet did not reduce anxiety in mice who were vagotomized.⁷

Bercik et al. helpfully elucidate the connection between inflammation and stress by noting that “pro–inflammatory cytokines can alter tryptophan metabolism, increasing levels of kynurenin, which is known to induce anxiety–like behavior.”⁷ Microbiota influences levels of inflammation, thereby impacting the state of anxiety or calm. Furthermore, other studies have shown that anxiety during acute stages of infection with harmful gut bacteria is associated with activation of vagal nerve pathways.⁷ Our brains may not be aware that something is amiss in our gut without the vagus nerve as a conduit.

Whether or not the mice in the study by Bercik et al. could sense their own anxiety or not, it is of interest that the researchers drew an obvious connection between colitis and anxiety and that B. longum effectively treated colitis. Although we must not confuse causation with correlation, we also should not dismiss the possibility that conditions like anxiety can be effectively treated at the gut level, particularly when a patient presents with anxiety/depression and GI tract trouble. One safe and effective way to treat GI disorders is through the use of probiotics.
As is widely known, fermented and probiotic foods are a staple in many traditional diets (e.g., kimchee in Korean cuisine, sauerkraut as a German staple, and kombucha as a health tonic in Eastern Europe and China). The benefits of curd (a common term for yogurt in India) are mentioned in traditional Ayurvedic teachings: “Curd is appetiser, digestive stimulant, aphrodisiac, unctuous, strength promoting, alleviator of vata, auspicious, and nourishing” (Charaka Samhita, vol. I, ch. XXXVII, verses 225–227). Thus, we see that for thousands of years many cultures have believed in the health benefits of consuming foods with certain beneficial bacteria.

Bested, Logan and Selhub (2013) refer to alterations in gut microbiota homeostasis as “dysbiosis.” They astutely point out the context in which probiotics, gut health, and mental health operate when they write that “induced states of dysbiosis can promote behavior indicative of anxiety and cognitive dysfunction in animals. On the other hand, psychological stress itself leads to dysbiosis, and it also encourages the consumption of a fast-food style diet, which only serves to further promote dysbiosis.”

Therefore, gut health and mental health are spokes in the wheel of a vicious cycle, with each one leading to the other. Furthermore, studies such as the one performed by Bercik et al. (2011) point out the importance of the vagus nerve in the communication between the gut and the brain. Not only is the health of the gut contingent on mental health and vice versa, but the highway between the two needs to be functioning in order for the gut to communicate effectively with the brain.
Moreover, the dietary context in which the probiotics are administered may make a huge difference. Isolated microbes might not have the same effect on health as probiotics in whole-food form. In the 1920s and 1930s, one researcher found that when he switched the food given to mice from the standard one to another that was banana-based, mortality rates fell drastically.\(^8\) Interestingly enough, modern research has drawn a connection between banana consumption and higher levels of bifidobacterium in stool samples. One study (Mitsou et al., 2011) showed that bifidobacterium levels were higher in a study group that consumed bananas on a regular basis.\(^9\) Bananas are considered a “prebiotic” because they provide food for healthy probiotics to flourish.

Returning to the mental health connection, “For now, we do know through preliminary research that the oral administration of GABA derived from Lactobacillus hilgardil fermentation has been shown to have clinical value in anxiety reduction.”\(^8\)

The findings of Park et al. (2013) support the likelihood that depression affects gut microbes. They performed a study on mice in which they induced depression through olfactory bulbectomy and then measured for signs of depression, colon motility, gut microbe makeup, and muscle contractility in the colon. Park et al. found that depression leads to a change for the worse in gut microbes:
An important finding in this study is the demonstration that experimentally induced depression is accompanied by a shift in the relative abundance of the resident microbes in the gut. . . Our findings indicate that depression leads to a change in the relative abundances of the commensal bacteria in the gut, and is most likely due to a change in colonic physiology altering the habitat for commensal bacteria.¹¹

A study done by Ait-Belgnaoui (2006) showed that administration of the probiotic L. farciminis had a protective effect on the gut-wall lining in a sampling of mice.¹² Ait-Belfnaoui draws a connection between gut permeability and abdominal pain and dysfunction found in patients with irritable bowel syndrome. Irritable bowel syndrome is also associated with psychological distress. “An increase in intestinal permeability has recently been described in post-dysenteric and other irritable bowel syndrome patients. Manifestations such as increased gut permeability and visceral hypersensitivity are similar to those initiated by various stressful stimuli in rats and mice.”¹² Essentially, exposure to stressful stimuli and the resulting psychological distress impact gut permeability. Probiotics improve gut permeability, and thus may relieve some of the associated psychological distress.

These findings are consistent with modern holistic health theories about the importance of “good bacteria” versus “bad bacteria” and yeast. In his book, Healing with Whole Foods, Paul Pitchford writes about the detrimental effects of
candida overgrowth. Candida is a yeast that can overtake the digestive system, inhibiting nutrient absorption and causing a host of diseases:

“Additionally, orthomolecular therapists often find that schizophrenic symptoms vanish when the patient’s hypoglycemic, allergic, and/or candida-yeast overgrowth conditions are relieved” (p.443).

In conclusion, it is clear that there is a strong correlation between gut health and mental health. The ancient rishis emphasized the pivotal role of digestive health on the health of the entire person, and modern evidence shows that what is in our gut has a profound impact on our health in a number of ways. At this point more human clinical trials are needed to determine whether administration of probiotics is an effective treatment for mental illness. However, animal studies show that probiotics effectively treat colitis and that colitis is linked to anxiety-like behaviors. Furthermore, we know that anxiety and depression are much more common in those with ulcerative colitis and Crohn’s disease, both of which cause ulcerations to the lining of the intestines, and that treatment with probiotics reduces gut permeability in animal samples. In addition, one cannot ignore the role of the vagus nerve in gut-brain communication. It is notable that without the vagus nerve intact, we may not be able to sense our own anxiety, particularly when the root cause is gut-related. While we wait for more evidence to come in, improving our gut health through wholesome eating habits and the intake of probiotics is a safe, risk-free, and
perhaps profoundly beneficial experiment that we can undertake on an individual level.

Works Cited


