

Article 47

A Healthy Gut and a Healthy Brain: Implications for Counseling and Lifestyle

Paper based on a program presented at the 2015 American Counseling Association, March 12–15, Orlando, FL.

Harriet A. Bachner

Bachner, Harriet A., is an Associate Professor of Psychology and Counseling at Pittsburg State University in Pittsburg, KS. She is a LCPC and LCMFT with 36 years as a counseling professional, formerly in psychiatric and residential treatment settings and private practice and currently as a counselor educator. Her current interests are related to trauma and lifestyle factors important to recovery, and diversity issues in counselor education.

Abstract

The complex interaction of diet, early development, and lifestyle has a reciprocal relationship with the body's microbial environment and emotional and neurological function. Understanding the enteric micro-environmental impact on gut and brain communication and modulation may help counselors develop strategies for assisting individuals to cope with stress-related and mood disorders. Recently, there has been burgeoning interest, both in research and in public discourse, about the effects of lifestyle and diet on mental and physical health. Some studies show a possible association between the gut microbial environment and stress-related, mood, and cognitive disorders, which interestingly coincide with many gastrointestinal problems. Counselors need to consider the profound implications for counseling regarding diet and lifestyle factors, as they may impact early emotional and cognitive development, particularly in the biopsychosocial aspects of family and individual well-being. Therefore, treatment can include some attention to the complex etiology and to the interplay of diet, lifestyle, and the gut microbiota on early development and the resulting neurological, emotional, and physical well-being.

Dora's counselor asks her, "What are the foods that you regularly eat?" She is puzzled as to what could possibly compel her counselor to inquire about this. She has been describing in great detail symptoms of her depression, worries, and her seemingly unrelenting life stressors. So what if she experiences occasional irritable bowel problems; who wouldn't, given all that has been happening to her? She wonders why her counselor had her complete an extensive intake form with questions about her birth, if she was

breastfed, her early childhood, and her mother's diet and overall health. She is puzzled about the relevancy of these questions as possible contributing factors to her current concerns. She is particularly distressed because she really cannot answer many of the questions about her infancy and early childhood that seem to be so important to her counselor. Dora is 60 years old, works full time for a high-pressure accounting firm, and cares for her ailing mother, who has been diagnosed as being in moderate stage Alzheimer's. She admits that because she has so many time constraints, she usually stops at a fast food restaurant to pick up dinner for her mother and herself. She rarely takes time to eat breakfast, but often has some fruit or yogurt on the way to her office. Her husband died of a massive heart attack 6 months ago, and she has been sorting through much of the financial business that he left unattended. She reports that she really has not had time to grieve the loss of her husband due to her work commitments and daily care for her mother. She knows little about her biological parents since she was adopted in her early infancy. According to her counselor, her symptoms may be in part related to or aggravated by what her counselor calls "leaky gut." Dora has no idea what her counselor means by this.¹

Introduction

Over the past decade there has been burgeoning interest about how our lifestyle and modern diet, replete with steroids and antibiotics in meat products, additives in highly processed foods, and toxins in our environment, affect our mental and physical health, specifically regarding the gut and brain connection (Costandi, 2012). The functions of the gastro-intestinal (GI) system have previously been considered to be limited to digestion and nutrient absorption. With further investigation though, the GI system is now viewed as a regulator. The intestinal lining provides a protective barrier that optimally prevents harmful inflammatory substances from passing through the body and central nervous system (CNS). The gut is involved in immune, endocrine, and nervous system functioning and thus influences mood, behavior, and physiology (Mayer, 2011). An increasing number of retrospective studies on humans and controlled animal research indicate a possible association between the microbial environment of the gut and stress-related disorders, depression, anxiety, obesity, eating disorders, and possibly some cognitive disorders. These disorders also seem to coincide with some GI problems (Cryan & O'Mahony, 2011; Mayer 2011). Since counseling focuses on biopsychosocial individual and familial well-being, the relevancy of a gut and brain connection to mental health may be profound. Thus, a health and lifestyle exploration, including a developmental history, prenatal through current life stage, would address the influence of physical and familial systemic etiology of presenting problems. This extensive counseling intake, inclusive of early development and wellness factors, would affect treatment and may mitigate the need to refer for psychotropic medication evaluation and instead warrant a consult with a nutritionist or a GI specialist.

The complex interaction of birth process, early and current diet, development, and lifestyle has a reciprocal relationship with the microbial environment of the body, particularly the gut, and the resulting emotional and neurological function. Providing information to clients about the enteric nervous system (ENS) and the micro-

¹ The case of Dora is fictional and derived from a variety of presenting concerns from several individuals.

environmental impact on gut–brain communication and modulation may help mental health professionals develop strategies for assisting clients who are coping with anxiety, stress-related disorders, and mood disorders (Cryan & O’Mahony, 2011). Thus, the focus of this article is three-fold: to briefly describe the gut–brain interaction loop of the ENS and the development of “leaky gut”; to identify some of the related research on the impact of the gut microbial environment on brain function, emotion, mental health, and disorders, such as anxiety and depression; and to propose strategies that counselors can use to integrate these findings in the process of helping clients develop a healthy lifestyle and diet, therapeutic in ameliorating stress-related disorders, depression, and anxiety.

The common expressions about emotions—“butterflies in my stomach,” “I have a gut feeling,” “my gut is in knots”—encompass the three components of emotion. These include physiological arousal, the perception of the situation, and the interpretation of resulting emotion, which have been conceptualized in a variety of different configurations. Mayer (2011) reflected upon theories about emotion, describing the processes and how each of these differ and yet add to the current understanding about the complex interaction of the brain and body response to stimuli. For example, in the James–Lange theory of emotion the focus is on bottom-up processing (Mayer, 2011). The stimuli produce physiological arousal and a response through the autonomic nervous system (ANS), and then that is interpreted as an emotion. There is a resurgence of interest in this theory, particularly regarding the emphasis on the physiological arousal and bottom-up processing. The Cannon–Bard theory contends that subcortical regions of the brain and the bodily changes are by-products of changes in the brain, or top-down processing (Mayer, 2011). Throughout the 20th century and into the current century, there has been a gradual understanding unfolding about how and where emotion is processed and experienced. Two examples include Damasio’s (1999) hypothesis about somatic markers or memories of visceral body states and responses or body loops; and more recently, Craig’s (2002) homeostatic emotion hypothesis, which involves sympathetic afferent input and parasympathetic input to the interoceptive cortex (Mayer, 2011). The growing body of research during the past 15 years gives credence to the earlier focus on the bottom-up approach to understanding and managing emotion and the common attributions that people give to their feelings and gut.

Gut–Brain Interaction and “Leaky Gut”

So what is the “gut–brain” and what does it have to do with emotion? Simply stated, it is the bi-directional communication system in which the brain sends messages to the gut and the gut sends messages to the brain, via the ENS through the vagus nerve, as though it is one system (Konturek, Brzozowski, & Konturek, 2011; Mayer, 2011). The ENS, a meshwork of nerve fibers that innervate the GI tract, pancreas, and the gall bladder, is now considered to be the third branch of the ANS, or the “second brain,” due to its complexity and size (Mayer, 2011). The gut and its diverse microbes may be considered the “forgotten organ,” with its flora beginning at birth or even prenatally and developing over an individual’s lifespan. It is influenced by genetic inheritance, the birth process, early diet, aging, the variety of foods eaten, pharmaceuticals, lifestyle, and exposure to environmental toxins (Konkel, 2013, p. A279). Since our gut and the associated microbiota play roles in the immune, endocrine, and nervous systems, it may

also influence mood, behavior, and physiology (Bercik, Collins, & Verdu, 2012). The ENS even has neurons, neurotransmitters, proteins, and signaling molecules similar to those in the CNS. The ENS modulates both the top-down and bottom-up signals of GI function that are affected by stress and emotional arousal, and thus it appears to play an important role in emotional regulation (Mayer, 2011). Since 90% of the messages that operate the gut come from the ENS and not the brain (Powley & Phillips, 2002), and the number of neurons in the ENS is equal to that of the spinal column, this complex GI maintenance may be very important in motivation, mood, and even higher cognitive functions (Mayer, 2011).

The other major influence on overall functioning of the human organism is the essential part played by bacteria. Bacteria have received much negative attention with little acknowledgment of the key roles that many good bacteria have in physical and mental health. Gut bacteria are important in the absorption of nutrients, in immunity (70% to 90% of immune cells are found in the gut), and maintaining the balance of healthy flora that impede toxins from entering the system, including the brain. These beneficial groups of bacteria, 80% of which are in the gut, (such as non-inflammatory bifidobacteria and lactobacilli) trigger the anti-inflammatory cytokine (non-antibody protein) that act as mediators in generating immune response. These bacteria, in addition to the fungi and flora ingested from food, boost immune function (Forsythe, Sudo, Dinan, Taylor, & Bienenstock, 2010; Isolauri, 2012). The gut immune system (GIS) and gut flora work together to crowd out the harmful bacteria. So if ingested pathogens cross the gut lining, the immune cells can secrete anti-inflammatory agents (Isolauri, 2012). It appears that sometimes pathogens, such as those consumed in our modern diet, may overwhelm and cross the gut lining. This could contribute to inflammatory conditions, such as irritable bowel syndrome (IBS), and possibly arthritis, depression, and Alzheimer's, and adversely affect mood and cognition (Dantzer et al., 2007; Kuhn, 2014). This disruption of the gut lining is referred to as "leaky gut" and may also be related to regular use of antibiotics, alcohol, anti-inflammatory medications, pain killers, infections, radiation therapy, gluten sensitivity, distress, and exhaustion. (Rodriguez, 2013). The leaky gut process compromises nutrient absorption and food intolerance may develop as antibodies are produced. This process is cyclical, in that those contributors to leaky gut could be the effects as well (Iliades, 2010).

Because 95% of the neurotransmitter, serotonin, as well as the neurotransmitters dopamine and GABA, are found in the gut, gut bacteria can play a part in increasing serotonin and stabilizing mood (Camilleri, 2009; Mayer, 2011). The small intestine is involved in the first step in serotonin production and an abundance of toxins in the gut may interfere with L-tryptophan's (an essential amino acid in our food) role in its conversion to 5-hydroxytryptophan and then to serotonin (Camilleri, 2009; Kuhn, 2014; WebMD, n.d.). The relationship here of gut-brain interaction to emotions is evident, for example, in the incidence of anxiety and mood disorders occurring more frequently in people who have IBS. In addition, studies have indicated that psychological interventions are important in helping people with IBS and the often associated depression. These may be even more effective in relieving symptoms than medical interventions (Fadgyas-Stanculete, Buga, Popa-Wagner, & Dumitrascu, 2014).

Food sensitivities, alcohol and drug abuse, stress, infections, and other harmful substances that might wreak havoc on the villi of the small intestine may also harm the

blood–brain barrier and possibly create what has been called “leaky brain.” An excessive amount of a protein named zonulin has been found to increase intestinal and brain permeability. Not only may the three types of barriers in the gut lining become compromised or overwhelmed by the previously mentioned toxins and substances, but also the blood–brain barrier could become permeable, leading to neurological problems and inflammatory conditions (Fasano, 2011; Sanelli, 2012). If the barriers in the gut fail to prevent pathogens from crossing the lining and the immune cells secrete inflammatory substances, other issues such as aging, climate, drugs, illness, and psychosocial stressors may increase a person’s vulnerability to developing “leaky gut” and “leaky brain” (Claesson et al., 2012; Kuhn, 2014). Recent studies suggest that depression, anxiety symptoms, aggressive behaviors, autoimmune disorders (lupus, arthritis), and even neurological changes in the brain that are associated with Parkinson’s, Alzheimer’s, and autism may be in part related to various bacteria strains and to “leaky gut” (Beydoun, Beydoun, Shroff, Kitner-Triolo, & Zonderman, 2013; Bravo et al., 2011; Cerf-Bensussan & Gaboriau-Routhiau, 2010; Dantzer et al., 2007; Fasano, 2011; Neufeld, Kang, Bienenstock, & Foster, 2011; Maes, Kubera, & Leunis, 2008; Mayer, 2011; Selhub, Logan, & Bested, 2014). Many of these experimental studies have been conducted on rodents and some are retrospective studies on children and older adults. Therefore, it is important to be mindful that much more is yet to be learned about the interrelationship of diet, environmental toxins, medications, and other possible challenges to the gut and brain barriers with mental and physical health. What is well understood and supported though is the two way communication through the ANS, the immune system, and the hypothalamic-pituitary-adrenal (HPA) axis (Neufeld et al., 2011, p. 255). Daniel Sanelli (2012), a holistic health and nutrition educator, writes in his Holistic Health and Nutrition blog,

Once the blood–brain barrier has been compromised, the brain is susceptible to damage from heavy metals, bacteria, environmental toxins and other harmful substances that would normally be banned from the brain. Leaky brain can lead to more serious neurological conditions like depression, ADD/ADHD, seizures, Autism, mental illness, and chronic pain. (para. 5)

Developmental Aspects of the Gut–Brain Connection on Health and Behavior

Early development of a diverse and healthy gut microbiota appears to have short- and long-term impact on the overall well-being of children. Healthy GIS development is triggered by contact with microbiota during the birth process and possibly even prenatally (Cerf-Bensussan & Gaboriau-Routhiau, 2010). The first few days after birth is “the beginning of a mutually beneficial lifelong relationship” of the gut with microbiota (Neufeld et al., 2011, p. 255). There is some evidence that even at 7 years old the child’s microbiota still resembles that of the mother. Infant immunity is also influenced by quality of the mother’s breast milk composition, which is affected by her weight, nutrition, and her resulting health and microbiota (Isolauri, 2012, p. 1). The infant ingests antigens and a mixture of compounds that stimulate the developing immune system and enhance the child’s ability to tolerate a variety of foods and minimize allergic reactions (Isolauri, 2012, p. 5). Thus, infant and early childhood immunity depends on the mode of delivery of nutrients (breast-feeding or formula), the strains of good bacteria, anti-

inflammatory compounds, cytokines, antigens, and the mother's immune health and diet (Isolauri, 2012). In contrast, babies born by C-section appear to experience more colic and crying and have slightly higher rates of asthma and allergies. In fact, a recent 5-year study showed consumption of highly processed foods, sodium snacks, and sugary drinks to be associated with an increased risk for behavioral and emotional problems in young children (Selhub et al., 2014). Another study of 2,054 Australian teens who consumed junk food over 2 years showed that their mental health worsened (Jacka et al., 2011). The Norwegian Mother and Child Cohort Study, the largest longitudinal study of its kind by Magnus et al. (2006), examined the diets of more than 23,020 women and their children. The diets of women and children that were composed of junk food during the mothers' pregnancies and the children's first 5 years predicted aggressive and hyperactive behaviors in the children.

From these and other studies, it appears that organ messages from the gut and the associated intestinal microbes may influence emotional arousal, affect, and possibly, memory (Mayer, 2011, p. 459). A hypothesis regarding depression referred to as the "inflammatory and neurodegenerative hypothesis" indicates that some individuals diagnosed as having major depression may experience fatigue and GI problems similar to that of some type of infection. This "sickness behavior" appears to be related to an increased inflammatory and immune response as in leaky gut (Maes et al., 2008). Selhub et al. (2014) contended that the "gut intestinal barrier is compromised in depression" (p. 3) and that a fat and sugar rich diet, along with stress and exhaustion, make the gut lining more likely to have "leakage." Mayer (2011) also reported that fat rich diets affect homeostasis and are associated with gut inflammation related to changes in the visceral afferent pathways (p. 461). Selhub et al. have found several studies which correlated a traditional diet (one can surmise that involves foods that are eaten as close as possible to their natural state, unprocessed or unrefined) with as much as 25% to 30% lower risk of depression or anxiety. Thus, as Dr. Felice Jacka, president of the International Society for Nutritional Psychiatry Research, contends, it seems that worldwide observational studies are pointing to the need for psychiatric settings and mental health professionals to focus on dietary changes with clients (Culinary Culprits, 2014).

Treatment Planning in the Case of Dora

Reflecting back on Dora's presenting concerns and the little that is known about her health and social history, there are some aspects that can be considered in developing her counseling treatment plan. Since she was adopted in her early infancy, her counselor could surmise that Dora did not have the benefit of her biological mother passing on the beneficial microbes through breast-feeding. These play a very crucial role in providing not only immunity, but also creating a healthy and diverse microbial gut environment (Isolauri, 2012). There is no information about her biological mother's health and diet during her pregnancy with Dora and Dora does not recall the types of foods that she ate as a young child. Dora did report that she often has been prescribed antibiotics to treat various frequent urinary tract infections that she has had throughout her life. It is possible that her GI flora have been radically compromised, thereby possibly increasing her vulnerability to developing leaky gut and the resulting inflammation in various body systems (Rodriguez, 2013). The other contributing factors in her life include her reliance

on highly processed food, the distress from the recent death of her husband, pressures in her career, and her time in caring for her mother who has Alzheimer's. Although Dora rather offhandedly refers to having occasional irritable bowel problems, this needs to be explored further by her counselor in order to ascertain the frequency and amount of discomfort that she experiences and to determine the need for consultation with a GI specialist or internist. Her counselor realizes that symptoms of anxiety and mood disorders are often reported by individuals who have IBS. There is a significant risk for depression, and psychological interventions are often helpful in treating these individuals (Fadgyas-Stanculete et al., 2014). Dora's counselor shares this information with Dora and gives her some articles to read as well as Web sites that provide explanation about leaky gut relating to her presenting problems. Her counselor also discusses the importance of changing her eating habits to include foods that are not highly processed. She gives Dora some referral names of nutritionists who may help her develop an eating plan for her and her mother. Her counselor then shows Dora how to begin gathering some baseline information to explore the relationship among variables such as her mood, irritable bowel occurrences, food that she eats, as well as messages she is giving herself about others' expectations of her. Dora's counselor also discusses calming and soothing strategies such as mindfulness practice, meditation, guided imagery, and relaxation. She allows Dora some time to decide which of these she may be most likely to integrate in her daily life. The counselor encourages Dora to also take stock of the environmental toxins that she may be regularly encountering, for example: pesticides, steroids in the meat she eats, or preservatives. Given that Dora has often taken antibiotics and painkillers, she may lack the amount of good bacteria that are crucial for maintaining a balance of healthy gut flora (Bravo et al., 2011; Claesson et al., 2012). Since this is quite a plethora of new information for Dora to consider and incorporate in changing her lifestyle, her counselor sequentially introduces these strategies and resources over the first few counseling sessions and encourages Dora to gradually make these changes as she experiences each successful shift in her behavior and mood.

Implications for Counseling and Research

The field of nutritional psychiatry has recently been recognized as more than an adjunctive or alternative to traditional medical and psychological treatment. In addition, more research in nutritional anthropology is currently underway in comparing the diets of people in Western countries to those who eat more traditional diets. Findings show significant differences, particularly in gut bacterial or microbiota diversity (Selhub et al., 2014). Given that counselors take a holistic or biopsychosocial approach in helping clients cope with their presenting concerns, focus on the effects of diet, lifestyle, and early development on the gut-brain connection may be an alternative to psychotropic medication in considering the complexity of neurological function. The effects on well-being are experienced during early infancy from the first substances introduced, ingested, and the nutrients absorbed. Therefore, it seems that a close examination of a client's diet, even from early childhood, is critical in evaluating the lifestyle effects on the presenting symptoms.

What are some steps that counselors can integrate into their practice, considering what is being learned from the gut-brain research? It seems that the first step would be to

educate oneself about the enteric nervous system, diet, and the gut–brain dynamics. It is important to learn about “good mood foods” and foods that have been found to help balance and diversify the gut flora. Simultaneously, counselors can engage in healthy eating and lifestyle behaviors. By monitoring the changes that they notice within themselves, physically, behaviorally, and emotionally, they then are able to pay particular attention to mood, energy level, and overall GI functioning. At a recent counseling conference, attendees to a workshop by the author on this topic were asked what they had to eat that morning. Not surprisingly, only a few had a breakfast that was not comprised of highly processed food or fast food.

The next steps relate to the types of intake and assessment questions for clients that relate to early developmental factors, such as birth process, breast-feeding, diet, and eating habits from infancy throughout childhood and adult life. This would be particularly helpful for new or prospective parents in giving them information about the importance of establishing a diverse and healthy microbiota for their children that enhances their immunity and overall health. It is also important to inquire about current and past GI distress, particularly in working with clients who present with symptoms of anxiety and mood disorders (Cryan & O’Mahony, 2011; Fadgyas-Stanculete et al., 2014). This practice may extend the intake process, but it can streamline the direction of treatment planning and determine the need for consultation with a nutritionist or other holistic health or medical specialists. For example, clients with major depression could be referred for a blood test to determine the presence of antibodies so as to rule out leaky gut (Kuhn, 2014; Maes et al., 2008).

Helping clients develop a baseline of targeted lifestyle behaviors and encouraging them to record their food intake and eating behaviors, as these may coincide with presenting concerns, could be an important aspect of the initial stage of treatment. Enhancing the clients’ understanding about the exquisite balance of healthy eating and targeting associated behaviors may help them realize the relief they may experience from not only any GI distress, but also from anxiety, stress, and depressive symptoms as well. Counseling involves an integrated approach in order to individualize treatment to meet the diversity of clients’ presenting needs and concerns. Therefore, addressing eating, the use of antibiotics, and exposure to environmental toxins from a lifespan perspective is crucial in dealing with the most intimate aspect of an individual’s well-being. Kaplan and Rucklidge (2014) emphasized that changes can be made in mental health care so as to “. . . rethink our current treatment approach. Prioritize lifestyle factors, healthy eating, exercise and psychological treatments and save medications for when these approaches don’t work” (p. 1).

Further investigation is needed to learn more about the specific mechanisms of the bi-directional crosstalk between brain and the digestive system. Studies about the role gut–brain signaling has in young child brain and neurological development through adulthood and how this influences behavior, affect, and coping strategies in managing stress, anxiety, or mood would provide important information that can be integrated in mental health treatment. These research questions in what is now referred to as nutritional psychiatry are relevant to counseling and treatment planning.

The focus on the gut–brain interaction loop has been showing much promise in providing another way of viewing and enhancing mental and physical health. This involves making informed decisions about diet, being aware of possible exposure to

environmental toxins, and use of medications. Mental health professionals are in a perfect position to take this holistic approach in influencing the well-being of adults and the next generation. Therefore, counselors can help themselves and their clients diversify and improve their gut microbiota and immune function as important steps in their biopsychosocial health. Integrating the evolving findings about the gut–brain interaction in counseling clients from a biopsychosocial framework provides a significant opportunity to work in prevention as well as intervention. .

References

- Bercik, P., Collins, S. M., & Verdu, E. F. (2012). Microbes and the gut-brain axis. *Neurogastroenterology & Motility*, 24(5), 405–413. doi:10.1053/j.gastro.2011.04.052
- Beydoun, M. A., Beydoun, H. A., Shroff, M. R., Kitner-Triolo, M. H., & Zonderman, A. B. (2013, June). *Helicobacter pylori* seropositivity and cognitive performance among U.S. adults: Evidence from a large nation survey. *Psychosomatic Medicine*, 75(5), 486–496. doi:10.1097/PSY.0b013e31829108c3
- Bravo, J. A., Forsythe, P., Chew, M. V., Escaravage, E., Savignac, H. M., Dian, T.G. . . . Cryan, J. F. (2011). Ingestion of *Lactobacillus* strain regulates emotional behavior and central GABA receptor expression in a mouse via the vagus nerve. *PNAS*, 108(38), 16050–16055. Retrieved from <http://www.pnas.org/cgi/doi/10.1073/pnas.1102999108>
- Camilleri, M. (2009, February). Serotonin in the gastrointestinal tract. *Current Opinion in Endocrinology, Diabetes, and Obesity*, 16(1), 53–59.
- Cerf-Bensussan, N., & Gaboriau-Routhiau, V. (2010). The immune system and the gut microbiota: Friends or foes? *Nature Reviews*, 10, 735–744.
- Claesson, M. J., Jeffery, I. B., Conde, S., Power, S. E., O'Connor, E. M., Cusack, S. . . . O'Toole, P. W. (2012, August). Gut microbiota composition correlates with diet and health in the elderly. *Nature*, 488(7410), 178–184. doi:10.1038/nature11319
- Costandi, M. (2012, July–August). Microbes on your mind: Bacteria in your gut may be influencing your thoughts and moods. *Scientific American Mind*, 23(3), 33–37.
- Craig, A. D. (2002). How do you feel? Interoception: The sense of the physiological condition of the body. *Nature Reviews Neuroscience*, 3, 655–666.
- Cryan, J. F., & O'Mahony, S. M. (2011). Viewpoint: The microbiome-gut-brain axis: From bowel to behavior. *Neurogastroenterology & Motility*, 23, 187–192. doi:10.1111/j.1365-2982.2010.01664.x
- Culinary culprits: Foods that may harm the brain (2014, January 30). *Medscape Medical News*. Retrieved from <http://www.medscape.com/viewarticle/819974>
- Damasio, A. R. (1999). *The feeling of what happens: Body and emotion in the making of consciousness*. New York, NY: Harcourt Brace.

- Dantzer, R., Bluthé, R. M., Castanon, N., Kelley, K. W., Konsman, J. P., Laye, S. . . . Parnet, P. (2007). Cytokines, sickness behavior, and depression. In *Psychoneuroimmunology*, (4th ed.; Vol. 1, pp. 281–318). Boston, MA: Elsevier/Academic Press.
- Fadgyas-Stanculete, M., Buga, A. M., Popa-Wagner, A., & Dumitrascu, D. L. (2014). The relationship between irritable bowel syndrome and psychiatric disorders: From molecular changes to clinical manifestations. *Journal of Molecular Psychiatry*, 2(4). doi:10.1186/2049-9256-2-4
- Fasano, A. (2011). Zonulin and its regulation of intestinal barrier function: The biological door to inflammation, autoimmunity, and cancer. *Physiological Review*, 91, 151–175. doi:10.1152/physrev.00003.2008
- Forsythe, P., Sudo, N., Dinan, T., Taylor, V. H., & Bienenstock, J. (2010). Mood and gut feelings. *Brain, behavior, and immunity*, 24(1), 9–16. doi:10.1016/j.bbi.2009.05.058
- Iliades, C. (2010). What is leaky gut syndrome? *Everyday Health*. Retrieved from <http://dx.doi.org/10.1016/j.phanu.2013.05.003>
- Isolauri, E. (2012). Development of healthy gut microbiota early in life. *Journal of Paediatrics and Child Health*, 48(Suppl. 3) 1–6. doi:10.1111/j.1440-1754.2012.02489.x
- Jacka, F. N., Kremer, P. J., Berk, M., de Silva-Sanigorski, A. M., Moodie, M., Leslie, E. R., Pasco, J. A., & Swinburn, B. A. (2011). A prospective study of diet quality and mental health in adolescents. *PloS One*, 6(9):e24805, 1–7. doi:10.1371/journal.pone.0024805
- Kaplan, B., & Rucklidge, J. (2014, November 14). Julia’s TEDx talk: Time to get serious about nutrition. *Mad in America*. Retrieved from Mad in America website: <http://www.madinamerica.com/2014/julias-tedx-talk-time-get-serious/>
- Konkel L. (2013). The environment within: exploring the role of the gut microbiome in health and disease. *Environmental Health Perspectives*, 121(9), A276–A281. Retrieved from <http://dx.doi.org/10.1289/ehp.121-A276>
- Konturek, P. C., Brzozowski, T., & Konturek, S. J. (2011). Stress and the gut: Pathophysiology, clinical consequences, diagnostic approach, and treatment options. *Journal of Physiology and Pharmacology*, 62(6), 591–599.
- Kuhn, M. (2014, March 3). *Understanding the gut brain: Stress, appetite, digestion, and mood*. Workshop presented for Institute for Brain Potential, Joplin, MO.
- Maes, M., Kubera, M., & Leunis, J-C. (2008). The gut-brain barrier in major depression: Intestinal mucosal dysfunction with an increased translocation of LPS from gram negative enterobacteria (leaky gut) plays a role in the inflammatory pathophysiology of depression. *Neuroendocrinology Letters*, 29(1), 117–124.
- Magnus, P., Irgens, L. M., Haug, K., Nystad, W., Skjaerven, R., Stoltenberg, C., & MoBa Study Group. (2006). Cohort profile: The Norwegian mother and child cohort study (MoBa). *International Journal of Epidemiology*, 35(5), 1146–1150. doi:10.1093/ije/dy1170
- Mayer, E. A. (2011). Gut feelings: the emerging biology of gut–brain communication. *Nature Reviews Neuroscience*, 12(8), 453–466. doi:10.1038/nrn3071

- Neufeld, K. M., Kang, N., Bienenstock, J., & Foster, J. A. (2011). Reduced anxiety-like behavior and central neurochemical change in germ-free mice. *Neurogastroenterology and Motility*, 23, 255–264, e119. doi:10.1111/j.1365-2982.2010.01620.x
- Powley, T. L., & Phillips, R. J. (2002). Musing on the wanderer: What's new in our understanding of vago-vagal reflexes? I. Morphology and topography of vagal afferents innervating the GI tract. *American Journal of Physiological Gastrointestinal Liver Physiology*, 283, G1217–G1225. Retrieved from <http://ajpgi.physiology.org/content/ajpgi/283/6/G1217.full.pdf>
- Rodriguez, T. (2013, November/December). Headlines - From bowel to brain: Microbes affect our mind. *Scientific American Mind*, 25(5), 7–9.
- Sanelli, D. (2012, September 12). What is leaky gut syndrome? *Primo Health Coach: Evidenced Based Nutrition that Works - Holistic Health and Nutrition Blog*. Retrieved from <http://blog.primohealthcoach.com/bid/81828/What-Is-Leaky-Brain-Syndrome>
- Selhub, E. M., Logan, A. C., & Bested, A. C. (2014). Fermented foods, microbiota, and mental: Ancient practice meets nutritional psychiatry. *Journal of Physiological Anthropology*, 33 (2), 1–12. Retrieved from <http://www.jphysiolanthropol.com/content/33/1/2>
- WebMD. (n.d.). l-tryptophan overview information. Retrieved from <http://www.webmd.com/vitamins-supplements/ingredientmono-326-l-tryptophan.aspx?activeingredientid=326&activeingredientname=l-tryptophan>

Note: This paper is part of the annual VISTAS project sponsored by the American Counseling Association. Find more information on the project at: <http://www.counseling.org/knowledge-center/vistas>